OBSTETRICS

AND

GYNECOLOGY

Edited by

ARTHUR HALE CURTIS, M. D.

Professor and Head of the Department of Obstetrics and Gynecology, Northwestern University Medical School; Chief of the Gynecologic Service, Passavant Memorial Hospital, Chicago

WITH 1664 ILLUSTRATIONS

VOLUME I

PHILADELPHIA AND LONDON

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PREFACE

THESE volumes are presented by the heads of departments and other prominent teachers in the leading medical schools of America. The Authors were chosen from a complete list of specialists in Obstetrics and Gynecology, and eminent teachers in allied fields. Although the Editor has intimate acquaintance with most of the contributors and personal knowledge of their scientific attainments, an exhaustive study of the literature has been a material aid in determining the appropriate authors for many of the chapters.

The work has been accomplished with a remarkable spirit of interest and cooperation; as a result, there has been produced a comprehensive and authoritative group of books on Obstetrics and Diseases of Women. The uniform excellence of the text bespeaks the untiring efforts of the contributors to give the best that can be produced in this field.

ARTHUR HALE CURTIS, *Editor*.

CHICAGO, ILLINOIS,
April, 1933.

CONTENTS OF VOLUME I

OBSTETRICS AND GYNECOLOGY

THE NEW SURGICAL LITERATURE

By Franklin H. Martin, M. D.

Chicago, Ill.

It is presupposed that the physician who accepts the responsibility of the medical custody of woman appreciates the magnitude and sacredness of his task. Without the intricate physical mechanism of woman, the human race would, in one generation, cease to exist. Endowed as she is with the faculties of reproduction, she is a supreme specialist in human activities. The consummation of her womanly function is wrought with such embarrassment and pain that her instinct for maternity must dominate these agonizing objections. In spite of the preachments of chastity and centuries of conventional rules of conduct, woman still possesses irrepressible sex desires that must be inherent if the human race is to continue.

Conception and its attendant processes are the marvel of all science. Its culmination is definitely timed by nature; a psychology of maternal instincts is created that often transforms the woman; nutrition is augmented to maintain the new life; development is accelerated; a delicate body expands to accommodate the new inhabitant; the organ of gestation increases in weight from a few ounces to several pounds, to sustain the embryo, the developing fetus, and the maturing offspring. As the result of a marvelous mechanism, in the last month of gestation a fluid secretion is formed—food in process of development to be stored in the reservoir of the breasts. At the given hour the supreme test is at hand, the forces of labor are established, and automatically there is brought about a softening of the outlets, and contraction of the highly developed uterus and the abdominal and pelvic muscles. In the final efforts, with the spontaneous cooperation of the mother, a child is born.

With the birth, a miracle of recession is wrought. The weight of the uterus diminishes gradually, the softened and dilated tissues resume their natural condition with remarkable promptness, and the breasts are filled with milk. A new individual has taken his independent place in society; a woman has become a mother. On this, her child's day of birth, she is happier than ever before. In two weeks, with new experiences in her soul, she goes forth realizing that she has been the instrument of the great miracle. If maternity is denied her, the reproductive organs suffer, and degeneration through uselessness may become a menace to health and happiness.

The men who have contributed to these volumes are foremost in their appreciation of these mysteries. They are best equipped to keep the marvelous machine in repair and to guide woman in solving the problems involved. Without exception, the authors are independent, practical men, leaders in their respective fields, each peculiarly adapted to deal with a particular

"Amenorrhea," and the century-old discussion of "Sterility," supplemented with their endocrine aspects. "Sex Problems," as dyspareunia, contraception and sterilization, are treated frankly but sanely. There is a comprehensive section on "Endocrine Aspects of Gynecology." Significant, though rarely adequately considered in gynecological and obstetrical literature, is the chapter entitled "Obstetrical and Gynecological Patients from the Viewpoint of the Neurologist." "Anesthesia" may be studied with great profit. "Blood Transfusion" is allotted an important place.

The text-book of that great master, Thomas Addis Emmet—especially its first chapter which discussed so interestingly woman as a distinct type of patient—will be recalled to the minds of many of us by the chapter on "The Gynecological Patient Presents Herself," most appropriately contributed by our Editor and chief.

The scientific contributions of a doctor represent a pure service to the profession of medicine, without expectation of material emolument. Real service is its own reward, and to the true physician reward comes from the satisfaction of unselfish aid to his confrères and to the public.

In cases of retained placenta, the author says:

> "The mydwif shuld anoynt her hondes and with hir nayles pullen owte the secundine if she mowe."

The first book on midwifery printed in England was *The Byrth of Mankynde, or the Woman's Booke* (Fig. 1), a translation into English of the Latin edition of Roesslin's *Rosegarten* (1513) which had appeared under the title *De Partu Hominis*. The English edition was published in 1540 by Thomas Raynalde[1] (printer) and contains copper engravings of the uterus and fetus, the first copper plates to appear in an English publication (Figs. 2, 3). It is certain that the English translation was made by Richard Jonas,

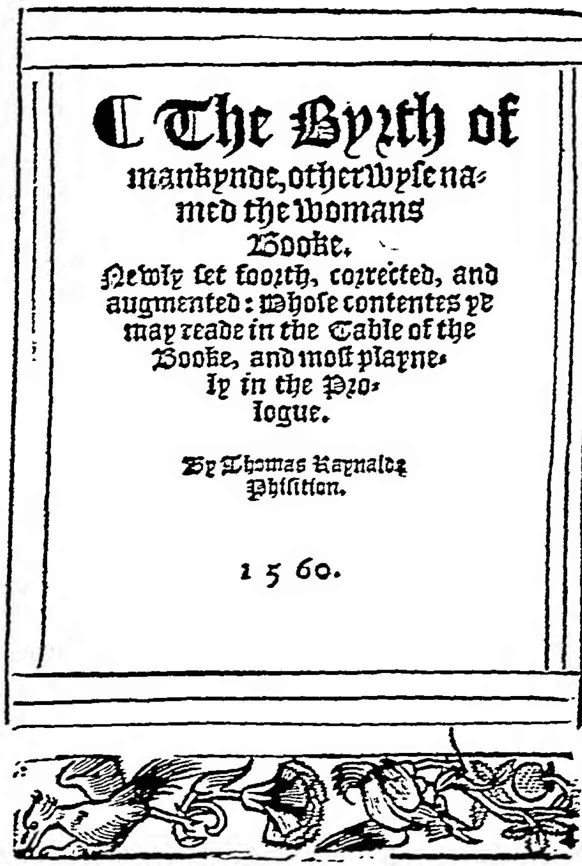

¶ The Byrth of mankynde, otherwyse named the womans Booke.
Newly set foorth, corrected, and augmented: whose contentes ye may reade in the Table of the Booke, and most playnely in the Prologue.
By Thomas Raynalde Phisition.
1560.

Fig. 1.—Facsimile of title page of the 1560 edition of *The Byrth of Mankynde*, by Thomas Raynalde.

although on the title page of the 1560 edition the name of "Thomas Raynalde, phisition" (fl. 1540–1551) appears. In the prologue Raynalde, the "phisition" says:

> "Wherefore now to come to oure pourpose ye shall understande, that aboughth a thre or foure yeres passyd, a certayne studious and dilygent clarke, at the request, and desyre of dyvers honest and sadde matrones beynge of his acquayntaunce, did translate out of Latin in to Englysshe a greate part of this booke, entytlinge it accordynge to the Latine inscription (de partu hominis, that is to say of the byrth of mankynde) which we do nowe name (The woomans booke)."

[1] Variously spelled Raynald, Raynalde, Reynald, and Raynold.

reader a glimpse of the obstetrical rules of the middle seventeenth century. One of Willughby's manuscripts, in the possession of the Royal Society of Medicine of London, was published privately in 1863.[1] Two paragraphs are quoted:

"Let midwives observe the waies and proceedings of nature for the production of her fruit on trees, or the ripening of walnutts and almondes, from theire first knotting to the opening of the huskes and falling of the nutt; the greene huskes sticking so close that it is not possible to separate the huske from the shell, whilst it is unripe; but as the fruit ripenneth the huske choppeth and with a fissure openeth, and by degrees separateth the fruit without any enforcement."

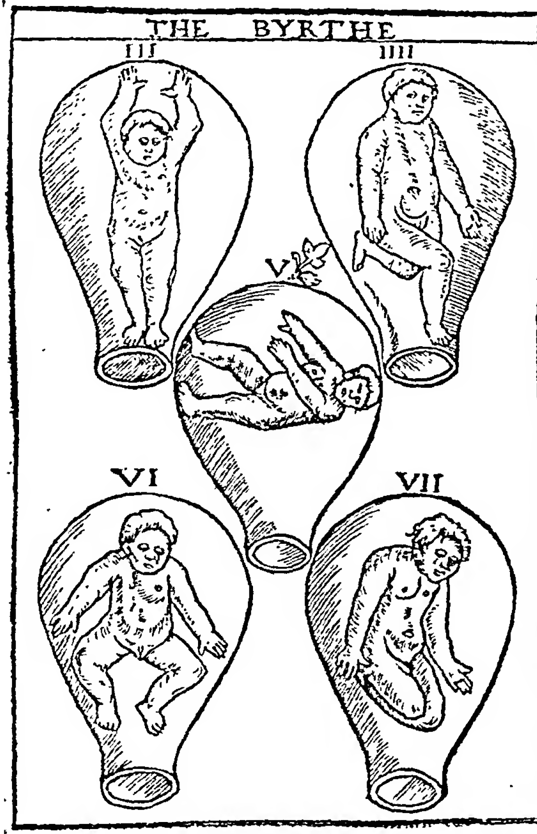


Fig. 3—Plate showing various presentations of fetus. From *The Byrth of Mankynde*, by Thomas Raynalde, 1560.

"An egge representeth the wombe; now the henne with keeping the egge warm doth breed the chicken, which when it comes to maturitie doth chip the shell, and is by degrees hatched without injurie. These signatures may teach midwives patience, and persuade them to let nature alone to perform her own worke, and not to disquiet women by their strugglings, for such enforcements rather hinder the birthe than any waie promote it, and oft ruinate the mother and usually the childe; and let midwives know that they be nature's servantes. . . ."

Of the systems of medicine and surgery, or anthologies of medical writings that appeared in great numbers in the latter part of the sixteenth and during the seventeenth centuries, one example will suffice: *The practice of physick*, of Lazarus Riverius[2] (1589–1655) published in London in 1678. This work

[1] Spencer, loc. cit.

[2] Lazarus Riverius was the first to hold the chair of iatro-chemistry at Montpellier. His *Praxis Medica* was first published in 1640.

After delivery the author prescribes a favorite procedure that occurs so often in seventeenth and eighteenth century writers:

"It is likewise profitable to apply the Skin of a Weather newly flead off, while it is warm, to her Belly. For this kind of warmth is very near of kin to our Natural heat, concocts and mitigates the cause of the pain; also it hinders the Skin of the Belly from gathering into wrinkles."

At the end of the chapter the author utters this note of thanksgiving:

"And so have we finished the Cures of Womens Sicknesses; All Praise and Honour to be given to God therefore."

A few of the numerous prescriptions that occur in *The Chyrurgians Closet* compiled by **Eduuard Poeton** of Petworth from the papers of the Right Worshipfull Mr. Thomas Bonham, Dr. of Physick[1] deal with pregnancy and gynecological conditions. A prescription for a plaster is given that

". . . staies the whites, and applyed to the lower region of the belly, it retaineth the fœtus, in such as are subiect to abort."

Another plaster is recommended to be applied hot to the

". . . . Nauell, helpeth the rising or strangling of the Matrix; and setleth it in the right place."

Another prevails "against all cold effects of the wombe." Vaginal "pessaries" are recommended for the purpose of drying up ulcers of the matrix:

". . . if at any time the Matrix be pinched with paine, arising from a hot cause; that then you ought to commixe a little *Opium* with your Anodinall ingredients, and therewith to cloath or arme your Pessarie: the which applyed duely as it ought, will blunt or dull the sharpnesse of such greefe or paine. But this rule must bee observed, that no opiated Pessary may be permited to remaine (within the Matrix) aboue the space of one halfe houre, least that thereby the membranous and neruous parts, should any way be hurt."

The immortal **William Harvey**[2] (1578–1657) (Fig. 4) may be justly considered the first English writer to make a substantial contribution to midwifery. *De Generatione Animalium*, published in Latin in 1651, was republished in English in 1653 (Fig. 5). One section in the English edition entitled "Of the Birth" consists of thirty-nine pages, in which Harvey mentions certain midwifery cases of his own as well as cases that had been referred to him by brother practitioners. He confesses himself a believer in superfetation[3] and seeks to justify his position by case citations. In this matter Harvey adopts the position of Aristotle. False pregnancies are mentionea. In one case he relates that he was unable to remove from a woman's mind the fixed idea that she was pregnant,

[1] Printed by George Miller for Eduuard Breuuster, London, 1630.

[2] William Harvey of Folkestone in Kent graduated B. A. Cambridge in 1597; studied at Padua from 1599 to 1602 or 1603 under Fabricius and Galileo (1564–1642); became physician to St. Bartholomew's Hospital in 1609 and Lumleian lecturer in 1615. He was physician extraordinary to Charles I. In 1628 he was treasurer of the College of Physicians.

[3] This phenomenon is denied by most English and German writers. Many French authors, however, attest the validity of a fertilized ovum developing in a uterus in which a fetus is already established. Several American case reports of superfetation from reliable authors have been recorded.

". . . and all the Arguments I could suggest, could not remove that perswasion from her: till at the last, all her hopes vanished into *flatulency* and *fatness*."

He recognized prolapse of the uterus and probably cystocele. Harvey does not describe the mechanism of labor, no doubt assuming that such a description does not fall within the scope of his title. He gives us, however, a sufficient number of comments to indicate that his practice of midwifery was not extensive. One point he strongly emphasizes, namely, that retention of portions of the placenta in the uterus is fraught with much mischief.

Harvey does not agree entirely with his old teacher, Fabricius (1537–1619), who ascribes the expulsion of the fetus to muscular contractions of the uterus, assisted by the "muscles of the lower belly and the midriffe." Harvey says:

"When I consider the matter thoroughly, the throws of the woman in travaile do seem to proceed from the Motion and Agitation of all the Body."

Harvey also adheres to the notion that the assistance of the fetus is necessary to delivery and he says that:

"The assistance of the foetus is chiefly required in the birth, is evident, not in Birds onely, which do by their own industry without the help of their Parent break up the shell; but also in other Animals; for all Flies, and Butterflies, doe perforate the litle membranes (in which they did lurk when they were the Worme Aurelia) and likewise the Silk-worm doth at his appointed time mollifie and erode the litle Silken Bagge, which he had weaved for his defence and security, and so gets out without any forraign aide."

Harvey cites the case of a certain woman

". . . here amongst us (I speak it knowingly) was, (being dead over night) left alone in her Chamber: but the next morning an Infant was there found between her Leggs, which had by his own force wrought his release. Gregorius Nymmanus, hath collected certaine examples of this nature out of approved authors."

John Maubray (d. 1732) published in 1724 *The Female Physician, . . . The Whole Art of New improv'd Midwifery . . .* (Fig. 6) a rambling, wordy treatise, replete with references to theological dogma. The volume appears to be the author's attempt to reconcile theology and astrology with what was known of the facts of reproduction. Nevertheless, Maubray makes many telling points that no doubt proved of value to the profession of the day. The work, however, cannot be considered as contributing in the slightest degree to the advancement of the science of midwifery. In his preface, Maubray shares with the reader of his treatise the satisfaction he feels that

". . . by the many happy Discoveries and strict Inquiries made into the Secrets of Nature, and Natural Causes, these Healing and obstetricious *Arts* are so much improv'd and advanc'd, that, they now seem to be arriv'd at their very Height of *Perfection* . . . "

In spite of the "height of perfection" which the art of midwifery had achieved, Maubray himself admits of many doubts, and of the existence of many unsettled questions. In the matter of the "Animation of the Foetus" he dips into astrology:

"The *Influx* of celestial Bodies exerts its Power very efficaciously in all *Sublunaries* and *Inferiours*. Hence, touching the *four Humours* of our Bodies, MARS is thought to excite the *yellow Bile*, as SATURN exasperates *Melancholy;* and LUNA to encrease *Phlegm*, as SOL and JUPITER govern the *Blood*."

Because of the numerous advances set forth by various writers on the practice of midwifery, Maubray says that the art has been placed upon such a firm mathematical foundation that the use of instruments is not only needless and superfluous, but "odious and ridiculous." The authors referred to by Maubray

". . . instruct us how to remedy the most difficult *Occurrences* by a right *Understanding* of the Business, and a nice subtile skilful *HAND* only, without any manner of other *INSTRUMENT;* excepting only in the Case of a *MONSTROUS* or *dead BIRTH.*"

Maubray enters upon a detailed description of the qualifications of the female midwife and sets up such rigid requirements that no one short of a paragon could qualify.

"SHE ought not to be too *Fat* or *Gross,* but especially not to have thick or fleshy *Hands* and *Arms,* or large-*Bon'd Wrists;* which (of Necessity) must occasion racking *Pains* to the tender *labouring Woman.* . . .

"SHE ought to be *Grave* and *Considerate,* endued with *Resolution* and *Presence of Mind,* in order to foresee and prevent ACCIDENTS; *Sagacious* and *Prudent* in difficult *Cases* so as not to take *All* upon her own Shoulders or *Judgment,* but to have immediate *Recourse* to the ablest *Practiser* in the ART, and freely submit her *Thoughts* to the discerning *Faculty* of the more Learned and Skilful. . . .

"SHE ought to be *Patient* and *Pleasant; Soft, Meek,* and *Mild* in her *Temper,* in order to encourage and comfort the *labouring Woman.* She should pass by and forgive her small *Failings,* and peevish *Faults,* instructing her gently when she *does* or says *amiss:* But if she will not follow *Advice,* and Necessity require, the MIDWIFE ought to reprimand and put her smartly in mind of her *Duty;* yet always in such a manner, however, as to encourage her with the *Hopes* of a happy and speedy DELIVERY."

He follows Deventer[1] (1651–1724) in believing that many difficult births are due to malpositions of the uterus and names four oblique situations that cause difficulty.

Of digital vaginal examinations, he says:

". . . after you have first pared the *Nails* short, equal, and smooth, *passing the two Fore-fingers of either Hand, (previously well anointed with Fat ar Butter, when proper Oils are not to be had) through the* VULVA *into the* VAGINA, *in order to reach the Orifice of the WOMB,* and to discern its FORM, by feeling it on each Side."

He notes that these examinations are to be fairly frequent during the force of the pains "the better to know their nature and effect."

During labor every precaution must be taken so that no breath of cold air may come in contact with the woman "else it occasion convulsions and other most dangerous accidents." He utters a timely caution relative to the delivery of the shoulders, stating that after the head is born, the body of the infant must not be drawn forward. On the contrary, the head is to be moved gently from side to side in order that the birth of the shoulders may more readily and easily take place. Mauriceau is quoted on numerous topics and

[1] A Dutch obstetrician who greatly influenced the future of French and English midwifery was Henry A. Deventer, who at the age of seventeen abandoned the trade of goldsmith for the study of medicine. He was the first serious student of the deformities of the female pelvis, and his work *The Art of Midwifery Improv'd* (English translation, 1716) was a superior book from the standpoint of the practitioner to that of Mauriceau. Only occasionally did he use instruments of any sort, and then not unless he encountered a monster or macerated fetus. He corrected Mauriceau's misconception of the growth of the uterus in pregnancy.

Light, it commonly *Yells* and *Shrieks* fearfully; and seeking for a *lurking Hole*, runs up and down like a *little Dæmon*, which indeed I took it for, the first time I saw it, and *that* for none of the *better Sort*."

He then goes on to relate that having occasion to take passage from the city of Harlingen to Amsterdam, a woman of the better sort, a passenger on the vessel, fell into labor. Maubray offered his services

". . . . and upon the *Membrane's* giving way, this forementioned ANIMAL made its wonderful *Egress;* filling my *Ears* with dismal SHRIEKS, and my *Mind* with greater CONSTERNATION.

"When not immediately recollecting what I had either heard or read of this *MONSTER*, I could not help continuing in my Surprize, until I heard some of our *Accidental Company* call it *de Suyger*, as they went about to kill it: Upon which I immediately laid the *Woman* of a pretty *plump* GIRL; who, notwithstanding all this, had no *Deformity* upon it, save only many *dark, livid* SPOTS all over its Body; . . ."

Maubray says that later in conversation with some of the most "learned men" he was told "de suyger" was expected in Holland by the midwives in about one birth in three.

The Female Physician consists of 420 pages and is one of the most attractively printed publications of the early eighteenth century.

In 1725 Maubray published a second work entitled *Midwifery brought to Perfection by Manual Operation.* This volume, designed primarily for his students, is a manual of practical procedure.

Maubray is credited with having organized the first regular teaching of midwifery in England with a planned course of lectures and with having suggested the erection of an infirmary designed exclusively for lying-in women. His teaching, probably conducted at his house in "new-Bond-street, over against Benn's-Coffee-House, near Hannover-Square," consisted of two courses of twenty lectures each, which were scheduled for Tuesday and Friday evenings between the hours of 5 and 6. He says:

"Two courses may be sufficient to qualify any students and dutiful hopefuls. . . . Thus in four or five months' time he may accomplish and perfect himself in this our noble art of midwifery."

Sir Richard Manningham (1690–1759) was the second son of Thomas Manningham, bishop of Chichester. He received his M. D. from Cambridge and after a period of general practice located in Jerym street, where he resided until his death in 1759, confining his practice to midwifery. His chief contribution was the establishment in 1752 of what later became the General Lying-In Hospital and still later, Queen Charlotte's Hospital. Earlier than this (1739) he had provided a few beds in a rented house adjacent to his residence. This latter establishment was the first attempt to segregate lying-in women in a public charity. Manningham was one of the popular teachers of midwifery of the day, and devised and used a manikin on which he demonstrated to his students the mechanism of labor. Various editions of Manningham's book, *Artis obstetricariae compendium tam theoriam quam praxin spectans* (Fig. 7), were published in 1739, 1740 and an English translation in 1744. Spencer[1] calls attention to the fact that Fasbender[2] misquotes Man-

[1] *The History of British Midwifery from 1650 to 1800.* London, 1927.
[2] *Geschichte der Geburtshülfe.* Jena, 1906.

and carried back to King George several fragments of the delivered rabbits. St. André says in his account published in 1727—*A Short Narrative of an Extraordinary Delivery of Rabbets, Perform'd by Mr. John Howard Surgeon at Guilford:*

"All these Facts were verify'd before his Majesty, on *Saturday, Nov.* the 26th (1726) by the Anatomical Demonstration of the first, the third, fifth, and ninth of these Animals,

SOME

OBSERVATIONS

CONCERNING

The WOMAN of *Godlyman*

In *Surrey.*

Made at *Guilford* on *Sunday, Nov.* 20. 1726.

TENDING

To prove her extraordinary Deliveries to be a Cheat and Imposture.

By CYRIACUS AHLERS, Surgeon to His Majesty.

LONDON:

Printed for *J. Roberts* in *Warwick-Lane.* 1726.

Fig. 8.—Facsimile of title page of Surgeon Ahlers' account of the "Rabbet Breeder" of Godlyman, 1726.

which were compared with the parts of two natural Rabbets, the one of the Age of four Months, and the other of five Days, Dr. *Steigerthal*[1] and Dr. *Tessier* being present . . . .

". . . . I shall relate what appear'd in the Dissection of two Rabbets, which I performed in the Presence of Mr. *Molyneux,* the very Day that we returned from *Guilford;*

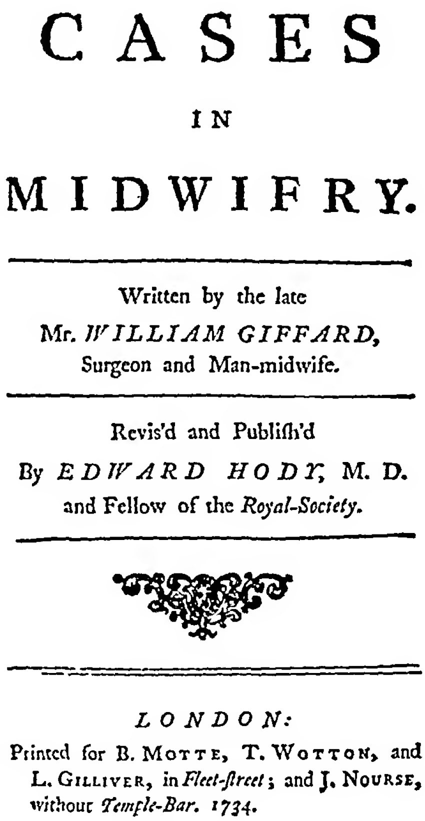
royal household. He was also local surgeon to the Westminister Hospital, then a dispensary. St. André only once presented himself at court after this exposure of the Mary Toft affair, and, although he retained his position of anatomist to the king until his death, he never drew the salary. There is a portrait of St. André in the engraving by Hogarth published in 1726, entitled: *Cunicularii, or the Wise Men of Godliman in consultation,* said to have been paid for by a few of the principal surgeons of the time, who subscribed their guineas to Hogarth for engraving the plate as a memorial of Mary Toft. St. André is represented with a fiddle under his arm, in allusion to his original occupation of a dancing master. He is described as "The Dancing Master, or Præternatural Anatomist." (See *Gentleman's Magazine,* 1842, vol. i, p. 366.)

[1] Johann Georg Steigerthal (b. 1667), M. D., 1690, University of Utrecht; physician in ordinary to George I; left England in 1727.

of danger and difficulty. I could wish indeed to have found his Language more correct; but it is with Books, as it is with Men, we ought principally to regard the *Use* they are of to Mankind: and I dare venture to affirm, that whoever shall peruse these Cases with an intent to *learn* the Practice of Midwifry, will not think his time ill spent."

Giffard's cases are examples of practical procedures; and most of the difficult situations are described with such clearness as to preclude misunderstanding. For example, Case X is termed "The Placenta foremost, with a Flooding." Giffard attended the case on December 5, 1725, and thus describes his management:

"I passed up two Fingers well greased, and found the inner Orifice dilated to the Breadth of a Crown, and very thin, within it was the *Placenta* lying foremost; wherefore, considering the Quantity of Blood she had already lost, and that it was still continually



CASES

IN

MIDWIFRY.

Written by the late

Mr. *WILLIAM GIFFARD,*

Surgeon and Man-midwife.

Revis'd and Publish'd

By *EDWARD HODY,* M. D.

and Fellow of the *Royal-Society.*

LONDON:

Printed for B. Motte, T. Wotton, and L. Gilliver, in *Fleet-street*; and J. Nourse, without *Temple-Bar.* 1734.

Fig. 9.—Facsimile of the title page of *Cases in Midwifry*, by William Giffard, revised by Edward Hody, London, 1734.

flowing, that her Pulse and Spirits began to flag, and that there was no prospect of a natural Delivery, I thought it advisable to deliver her immediately. I well greased my whole Hand, and passing it up, I met with some Clods in the Passage, which I removed, and then getting my Fingers into the inner Orifice, found the *Placenta* pressing hard upon it almost on every Side; with some Difficulty I passed up my Hand on one Side, and the first Thing I met with was the Child's Head, therefore I advanced further and found one of the Feet wrapped in the Membranes, which, pulling towards me, I drew out, and taking hold about the Ankle with a soft Cloth, brought it forwards (the other Leg lying bent upon the Belly) to the Buttocks, and so on to the Hips, but not without some Difficulty; taking fresh hold, I pulled it as far as the Shoulders, and brought down the Arms, and then clapping one Hand under the Breast to support it, with the other I took hold above the Shoulders, and endeavoured to draw out the Head; but Finding it stuck, I advanced my two Fore-fingers and got

soon as I came there, the Midwife shew'd me a Lump as big as my two Fists, which she had brought away just before I came; she likewise informed me, that she felt more lying in the Passage, but that she was afraid to bring it away: Wherefore I directed her, the Gentlewoman being unwilling that I should Touch her, to pass up either her Fingers or Hand, and to draw it away; which done, the Flooding and Pain ceased; this Lump was larger than the former: After this I was desired to touch, when I found the *Uterus* drawn upwards, and the *Os internum* contracted close; but upon taking away the foul linen, there was another piece found as big as two large Walnuts. I examined these Substances, and found them to consist of a Number of Hydatides, some larger, others smaller, join'd together by a loose Parenchymatous Substance, so that in some measure they represented large Bunches of Grapes, only that some of the Bladders were as large as Walnuts, others smaller."

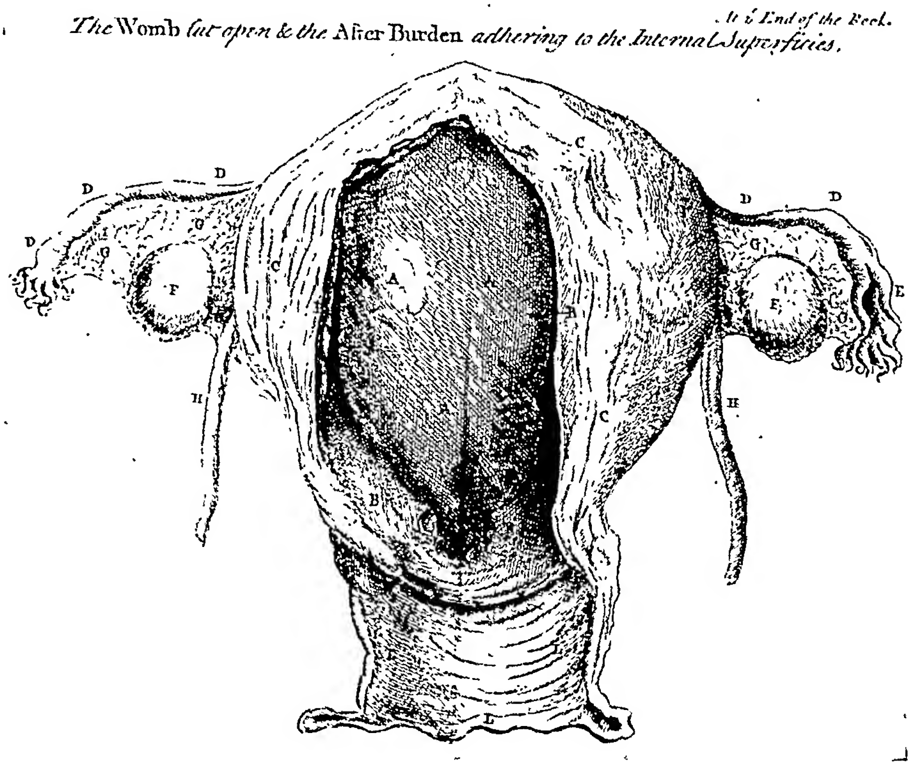


Fig. 10.—Engraving of hydatiform mole (labelled by Dr. Hody the "After-Burden"—AA). From Edward Hody's edition of *Cases in Midwifry* by William Giffard, London, 1734.

To this case the editor, Dr. Hody, adds the following:

"A Few months before Mr. Giffard died, on the 6th of *March*, 1730–31, the Gentlewoman, mention'd in this Case, was delivered of several large substances, form'd from a great number of *Hydatides*, join'd together by a loose Parenchymatous Substance. From that time to the day of her death, she was subject to sudden and pretty frequent gushings of blood from the Womb, which would last for a day or two; nor was she ever quite free from a draining, sometimes more, sometimes less colour'd with pure red blood. These were all her complaints, except a weight or bearing down upon the parts of generation; 'till about ten days before she died; when a small fleshy Substance came away from the Womb, and from that time she complain'd of violent pains in her belly, and died of a Fever and Mortification in the Womb on the 7th of *March*, 1731–32."

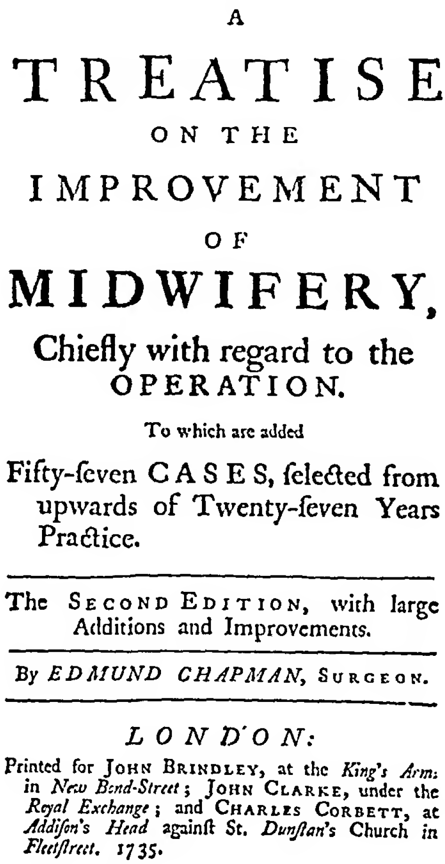
"Upon opening the Body, we found the Womb as represented in the Figure annex'd." (Fig. 10.)

Dr. Hody expresses the opinion that Dr. Giffard should have delivered this "afterburthen" at the time the patient was delivered of the hydatids.

"The Case is now far otherwise: The best Midwives commonly send for Advice upon the Appearance of Danger; the Suffering Fair readily consent to it, and by this Means both the Child's and Mother's Lives are saved, the *Midwife's* Character secured, and *ours* advanced, by the Success that usually attends our being called in time."

Chapman refers to Chamberlen's translation of Mauriceau, and to the works of Deventer, Dionis and Guillemeau as the chief sources of information on obstetrics.

Chapter II is devoted to his method of version. He agrees with Deventer and Giffard that when an arm presents, unless it can be easily returned above the brim of the pelvis, it is best to perform version and permit the


A

TREATISE

ON THE

IMPROVEMENT

OF

MIDWIFERY,

Chiefly with regard to the OPERATION.

To which are added

Fifty-ſeven CASES, ſelected from upwards of Twenty-ſeven Years Practice.

The SECOND EDITION, with large Additions and Improvements.

By *EDMUND CHAPMAN*, SURGEON.

LONDON:

Printed for JOHN BRINDLEY, at the *King's Arms* in *New Bond-Street*; JOHN CLARKE, under the *Royal Exchange*; and CHARLES CORBETT, at *Addiſon's Head* againſt St. *Dunſtan's* Church in *Fleetſtreet*. 1735.

Fig. 11.—Facsimile of the title page of *A Treatise on the Improvement of Midwifery*, by Edmund Chapman, second edition, London, 1735.

arm to pass upward as the feet are brought down. In his conclusion he says that after a hard labor and where there has been a necessity of some violence, the woman is to be treated as one bruised by a fall and here commends:

". . . the wrapping of the Body round with a *Sheep's-Skin*, hastily flead off, and applied as warm as possible."

In his concluding paragraph, he says:

"Since the Publication of my First Edition, I have had the Pleasure of instructing several Gentlemen in the Art; and among others, besides the Gentleman, whose Letter I have inserted at Length, Dr. W. Weltden, Mr. Smither of Reading, and Mr. Philip Haste, jun. of Coggeshall in Essex."

advised leaving the arms extended above the head in breech extractions. Ould says:

"In the Directions for bringing the Child forth by the Feet, the same Author adviseth the greatest Piece of Cruelty that can be imagined; namely, to leave the Hands to come out together with the Head; the Absurdity of which Practice is obvious to any Person who ever delivered one Woman, even in a natural Labour; indeed if he had advised this Practice in a Miscarriage, after six Months Pregnancy, and where there is an immoderate Flux of Blood; then this Method, for Expedition, might be commendable."

The delivery of the after-coming head as described by Ould is practically identical with that of Giffard. Ould says:

"The Hand under the Breast will support the Child's Weight, while the other must be layed on its Back, with two Fingers bent over each Shoulder, on each Side the Neck; thus it must be drawn forward, moving it from Side to Side, till it is compleatly extracted."

Ould calls attention to the error in the commonly accepted belief that the cervix is apt to contract and retain the placenta; that nature never intended the placenta to be separated from the uterus by the hand and that the expulsion of the placenta should be left to the uterus.

Ould suggests the operation of episiotomy in a characteristic paragraph. The modern modification of this procedure is of importance in the present-day practice of obstetrics.

"It sometimes happens, though the Labour has succeeded so well, that the Head of the Child has made its Way through the Bones of the Pelvis, that it cannot however come forward, by Reason of the extraordinary Constriction of the external Orifice of the Vagina; so that the Head, after it has passed the Bones, thrusts the Flesh and Integuments before it, as if it were contained in a Purse; in which Condition if it continues long, the Labour will become dangerous, by the Orifice of the Womb contracting about the Child's Neck; wherefore it must be dilated if possible by the Fingers, and forced over the Child's Head; if this cannot be accomplished, there must be an Incision made towards the Anus with a Pair of crooked Probe-Sizars; introducing one Blade between the Head and Vagina, as far as shall be thought necessary for the present Purpose, and the Business is done at one Pinch, by which the whole Body will easily come forth.

"AFTER the Delivery, the Wound must be taken Care of; if the Incision be made so near the Rectum as to weaken its Contraction, the Wound must be united by a Stitch, . . ."

Ould discusses at some length the most suitable posture for the woman to assume during labor. In his own practice the lateral position (right or left) was generally followed and he used this same position when making a vaginal examination. He objects to the woman being placed on her back because of the difficulties encountered should manual interference be indicated. He also objects to the perforated chair recommended by Deventer and says that of all of the postures which women are required to assume the lateral position is most advantageous with the operator and assistants behind the patient's back. Occasionally in difficult labors he believes that the knee-chest position may be resorted to. This posture described by Ould is recommended by Burton and his description follows Ould's almost word for word.

While complimenting the physicians and surgeons educated in Dublin, Ould says:

". . . yet I cannot help declaring the Necessity of being indebted to *France* for the true Knowledge of practical Midwifry. . . ."

aroused early in his practice, for in 1727 we find him using the blunt hook, the knowledge of which he attributed to John Gordon of Glasgow. Smellie's attention was attracted to the esssay on forceps by Alexander Butter shortly after its publication in 1735, and it was not long after this date that he records using the forceps. With a better knowledge of the forceps as his objective he set out for London in the latter part of 1738, or early in 1739. He writes:[1]

> "I afterwards perused the treatises of Chapman and Giffard, who had frequently saved children by a contrivance of this kind; and actually made a journey to London in order to acquire further information on this subject. Here I saw nothing was to be learned, and by the advice of the late ingenious Dr. Stewart,[2] who was my particular friend, I proceeded to Paris, where courses on midwifery were at that time given by Gregoire (junior)."

Of his experience in France, he felt compelled to express his disappointment at what he was able to learn. Late in 1739 or early in 1740 Smellie returned to London, secured a house in Pall Mall, and began the practice of midwifery. Within two years, thereafter, he was to receive as his house-pupil, William Hunter who was recommended to Smellie by his friend, William Cullen (1712–1790). It is reasonably certain that Smellie attended Frank Nicholls'[3] lectures on pathological anatomy and those of Desaguliers[4] on natural philosophy, evidently with the design of perfecting himself as a teacher, and the year 1741 marks the beginning of his rôle as an instructor in midwifery. Smellie's teaching career in London, his publications, and his safe and sane methods of practice, established him as the leading exponent of midwifery in England. Through his writings his teachings spread throughout the world and his work became better known than that of any other obstetrician of his day. Fasbender[5] says of Smellie:

> "He was one of the most important obstetricians of all times and of all countries."

His many useful devices and procedures are too well known to require extensive mention.

While in London, Smellie renewed his Glasgow college friendship with Tobias Smollett[6] (1721–1771) who was to lend his literary skill to the perfec-

[1] Glaister, loc. cit.

[2] Probably Dr. Alexander Stuart, M. D., Leyden, 1711; senior physician to St. George's Hospital, 1733–1736; Fellow of the College of Physicians.

[3] Frank Nicholls (1699–1778) was a son-in-law of Richard Mead (1673–1754); at one time Lumleian lecturer of the Royal College of Physicians, from which he later resigned (1749).

[4] John Theophilus Desaguliers, a Huguenot refugee, graduated from Christ Church, Oxford, gave public lectures on natural philosophy, the first series of which began about 1710. These were later given at the home of Mr. Hauksbee (d. 1713). Desaguliers was a Fellow of the Royal Society.

[5] Loc. cit.

[6] Tobias George Smollett was apprenticed at the age of fifteen (1736) to Dr. John Gordon, surgeon of Glasgow. After three years of study he made the journey to London and says that his travelling equipment consisted of "a small edition of Horace, Wiseman's Surgery, a case of pocket instruments, some clothing and a little cash." For a time he served as a surgeon in the British navy, later locating in the practice of surgery in Downing street. He passed the examinations and was admitted to the Corporation of Barbers and Surgeons. In 1750 he obtained the M. D. degree from Marischal College in Aberdeen. Literary work consumed the larger portion of his time and *Roderick Random*, *Gil Blas*, *Peregrine Pickle*, *Humphrey Clinker* and many additional titles are well known. He is referred to in contemporary literature as "the famous Dr. Smollett."

on practically every page and the numerous references to older writers are frequently without point and add only to the confusion and redundancy of his narrative. He has, of course, borrowed liberally from contemporary authors, which he admits, but occasionally the uncredited borrowings are extensive. The suggestion of Ould relative to the delivery of the after-coming head, that in making traction the body of the child shall be moved gently from side to side appears in Burton's book[1] well-nigh verbatim. Burton says: "This is the common practice."

A case which he delivered by version after the failure of a surgeon and a midwife, is described with a dramatic flourish:

> "I then told the Surgeon who was with her, that as he had been first sent for, I would compliment him so far, as to give him another Opportunity of delivering her, but he declined it, saying he could not do it. I then prepared myself, and giving my Watch to one of the By-standers, I desired her to observe how long I should be in delivering the Patient; and then begun, and delivered her of the Child, and fetched the After-birth also, in less than half a Minute by the strictest Observation. How the Surgeon and the By-standers looked at each other in Amazement, is easier to be imagined than expressed."

Burton concludes his essay:

> ". . . . I flatter myself, that the Improvements which I have made in the Method of *Practice*, for the Preservation of both Mother and Child, and the several vulgar Errors which I have refuted, will sufficiently attone for the Size of the Book."

In Burton's essay one misses the practical approach and definite procedures set forth in Giffard's Cases and by Chapman, Pugh and Smellie. There is an absence of the easy flowing style of Denman and the ostentatious display of classical learning adds little to the practical utility of the treatise. One can readily visualize Burton as a peppery sort of individual. He was hypercritical of the work of others and extremely sensitive to criticisms of his own productions. In his preface, apparently smarting under some earlier criticism, he says:

> "But for those People, who like *Birds of Night scream in the Dark*, when none can see them; and like *cowardly Enemies, unseen*, shoot their invenomed Darts at me, in *secret Whispers*, or *anonymous Papers*, such *Creatures*, may spit their *malignant Choler*, till it consume *Themselves*, before I shall regard them in the least."

In the light of this promise to remain silent should critics censure him, his vicious attack on Smellie is utterly inconsistent.[2] He holds Smellie's scholarship up to ridicule, he jibes at his thoroughness and concludes that he is a pure theorist and a poor practitioner. The most telling point which Burton makes against Smellie is in connection with Smellie's references to older writers, all of which Burton declares Smellie took from a compilation by Spachius:[3]

[1] Cf. Burton, p. 197, and Ould, p. 113.

[2] *A Letter to William Smellie*, etc. By John Burton. London, 1753.

[3] Howard Kelly in the *Johns Hopkins Hospital Bulletin* (vol. ii, Dec., 1891) published the following note on Israel Spachius:

"Spachius was born in Strassburg in 1550, studied medicine at Tuebingen, returned to Strassburg where he was made Professor, and died 1610. The title of his work is 'Gynecology, or the Diseases of the Pregnant, of Woman in Labor and in the Puerperal State, collected from the Works of the Greeks, Arabs, and Romans.' This book is peculiarly

goire, and at Rheims where he secured his M. D. degree. After completing his medical training, he settled in Wakefield, later moving to York, where in 1740 he was one of the prime movers in the founding of the York Hospital, being elected its first physician. His *Monasticon Eboracense* (1758) is an admirable example of his scholarly interest in antiquarian research. Despite Burton's hypercritical attitude toward the work of others, he was public-spirited and identified himself with forward-looking political and social movements of the day.

Benjamin Pugh, a surgeon in Chelmsford, published his treatise on midwifery in 1754 (Fig. 14). In the preface he mentions Ould, Smellie, and Burton

A

TREATISE

OF

MIDWIFERY,

CHIEFLY

With Regard to the OPERATION.

WITH

Several Improvements in that ART.

To which is added,

Some CASES, and DESCRIPTIONS with PLATES of feveral new Inftruments both in MIDWIFERY and SURGERY.

BY

BENJAMIN PUGH, Surgeon,
At Chelmsford, in Effex.

LONDON:

Printed for J. BUCKLAND, at the Buck, in Pater-nofter-Row.

MDCCLIV.

Fig. 14.—Facsimile of the title page of *A Treatise of Midwifery* by Benjamin Pugh, London, 1754.

as having "obliged the world" with three excellent treatises on midwifery, and he then notes that since every young surgeon now intends practicing midwifery and since

". . . it is become almost as universal amongst Men in this Kingdom as ever it was *in France;* I think every Help must be acceptable to the young Practitioner, ..."

First of all he offers a few wise cautions to the aspirant to obstetrical fame.

"No Man ought to think of practising Midwifery that has not been well instructed by some skilful Operator, and has been present at many preternatural, as well as natural Births. Consider there are two Lives at Stake, and no Man of any Goodness and Humanity will do a bad Thing.

"I introduced into the Child's Mouth, as near to the Larinx as I could, the other End external, which I found answer; but now, as I find my Fingers will generally answer, I seldom make use of it."

The balance of Pugh's maneuver is identical with that of Giffard and Smellie, Pugh adding

". . . when the Head is come through the Bones, and the only Hindrance is the external Parts, stand up, raise the Child, and extract the Head, by pulling with a Turn upwards with one Hand, and pressing the Parts back with the other; . . ."

He cautions against using too much force and notes that if the operator has difficulty in delivering the after-coming head, the left hand is still to retain its place—"never let that go." He then directs the midwife or one of the assistants to fix her hands over the lower portion of the mother's abdomen

". . . bidding her press down pretty strongly, you pulling the Child at the same time; and by this Method, and with such Assistance I have never once failed of Success, . . ."

Spencer[1] calls attention to the fact that Pugh in performing podalic version was one of the first, if not the first, to describe the use of the hand externally on the mother's abdomen. Pugh says:

"The Hand remaining in the Womb, and the other Hand (remember) externally upon the Belly, your Arm between the Thighs gently pressing, to assist the Hand in the Womb, then bring down the other Foot even with the other. . . ."

In Chapter XXII, Pugh describes placenta praevia, notes the danger to both mother and child, and advocates prompt delivery with the appearance of unusual hemorrhage:

". . . from the Moment the placenta is separated from the Womb, the Operator must slide his Hand on one Side, break the Membranes, let out the Waters, and extract the Child by the Feet immediately."

One is inclined to read Pugh as though written in 1750 before an opportunity had been offered to revise his manuscript in the light of Smellie's treatise (1752). Pugh's ingenuity commands our admiration.

William Hunter (1718–1783) (Fig. 15) was born at Long Calderwood, Lanark. He entered the University of Glasgow at the age of thirteen and pursued the study of theology for five years. By the end of that period he had become convinced that he did not wish to follow the ministry. Fortunately he had become acquainted with William Cullen (1712–1790) who had established himself as a surgeon at Hamilton, and who agreed to serve as Hunter's preceptor in medicine. This arrangement with Cullen lasted for three years and, as Hunter says, was "the happiest period of my life." After a short period of study in Edinburgh, Cullen advised Hunter to journey to London to further his prospects and in due time, armed with suitable letters of introduction, he presented himself at Smellie's London residence "in the New Court, formerly the Key and Garter Tavern, over against St. Alban's Street in Pall Mall." There he resided as a pupil from November, 1740,

[1] Loc. cit.

where one plate, already furnished by Mr. Strange, may be seen as a specimen, and where the Proposals may be had."

Additional information relative to his forthcoming *Gravid Uterus* is noted in his advertisement of 1753:

> "His figures of the Gravid Uterus have now been some time in the hands of the engravers and will be published with all the expedition that the nature of the work admits of. Those gentlemen therefore who have desired the author to put down their names as subscribers are hereby informed that the first payment will now be received."

In 1756 Hunter changed his residence to Jermyn Street, "a more respectable and convenient situation for practice," where he maintained two es-

ANATOMIA

UTERI HUMANI GRAVIDI

TABULIS ILLUSTRATA.

AUCTORE

GULIELMO HUNTER,

SERENISSIMAE REGINAE CHARLOTTAE MEDICO EXTRAORDINARIO

IN ACADEMIA REGALI ANATOMIAE PROFESSORE,

ET SOCIETATUM REGIAE ET ANTIQUARIAE SOCIO

BIRMINGHAMIAE EXCUDEBAT JOANNES BASKERVILLE, MDCCLXXIV

LONDINI PROSTANT APUD S BAKER, T CADELL, D WILSON, G NICOL, ET J MURRAY

THE ANATOMY

OF THE

HUMAN GRAVID UTERUS[1]

EXHIBITED IN FIGURES.

BY

WILLIAM HUNTER,

PHYSICIAN EXTRAORDINARY TO THE QUEEN, PROFESSOR OF ANATOMY IN THE ROYAL ACADEMY, AND FELLOW OF THE ROYAL AND ANTIQUARIAN SOCIETIES

PRINTED AT *BIRMINGHAM* BY *JOHN BASKERVILLE*, 1774.

SOLD IN *LONDON* BY S *BAKER* AND G *LEIGH* in York Street, *T CADELL* in the Strand, *D. WILSON* AND *G. NICOL*, opposite York Buildings, AND *J MURRAY*, in Fleet Street

Fig. 16.—Facsimile of the title page of the famous Baskerville edition of the *Anatomia uteri humani gravidi* by William Hunter, Birmingham, 1774.

tablishments—one a private residence with consulting rooms and the other his dissection laboratories, but it was not until 1760 that he closed his establishment in the Great Piazza where, since 1756, his brother John (1728–1793) had been conducting anatomical lectures and researches. In response to the earnest solicitation of a number of his pupils, William Hunter gave one final course of lectures in 1761.[1] During this period, his work on the *Gravid Uterus* probably occupied most of his spare time.

In spite of his increasing practice, his old love for anatomy had not abated and it occurred to him that the establishment of a permanent school of anatomy would be a wise use of his rapidly accumulating funds. To this end he

[1] Subsequent lectures on anatomy were delivered by John Hunter and William Hewson.

Some of the parts were given to him which he afterwards showed at his lectures, and probably they still remain in his collection. . . . The facts being now ascertained and universally acknowledged, I consider myself as having a just claim to the discovery of the structure of the placenta, and its communication with the uterus, together with the use arising from such structure and communication, and of having first demonstrated the vascularity of the spongy chorion."

Shortly after this incident, Colin Mackenzie began teaching midwifery independently in the borough of Southwark, and it was while there that William Perfect became one of his pupils. Mackenzie was a bachelor with ample means, a genial companion, and refused to be drawn into a public discussion of the quarrel between William Hunter and his brother John.

Many honors came to William Hunter. In 1747 he was made a member of the Corporation of Surgeons; in 1748 he was appointed to the Lying-in

Fig. 17.—William Perfect. (From the author's collection.)

Department of the Middlesex Hospital, and in 1749 he was made surgeon-man-midwife to the British Lying-in Hospital. In 1750 he was granted the degree of M. D. from Glasgow. In 1756 he became a licentiate of the College of Physicians, giving up surgery for which he apparently had but little talent. His election to the Royal Society occurred in 1767 and on the death of John Fothergill (1712–1780) he was elected president of the Society of Physicians.[1]

William Perfect.—*Cases in Midwifery* by William Perfect (1737–1789) (Fig. 17), surgeon of West Malling in Kent, was published in two volumes at Rochester. The first volume of the first edition is without date, the second

[1] This Society sponsored the *London Medical Journal*, the first volume of which appeared in 1781.

He was one of the most successful and popular teachers, and among his students were numbered many from America and the Continent, including the celebrated Lucas John Boër of Vienna, who attended his lectures and demonstrations for an entire year. As we shall later note Leake gave particular attention to puerperal sepsis.

His *Syllabus of Lectures on Midwifery* (London, 1787), of which numerous editions were published, is a prospectus describing the nature and character of his lectures and the opportunities offered students. He announces that ten-guinea pupils will be allowed to attend Westminster Lying-in Hospital "in which upwards of six thousand patients[1] have been delivered, and where

Fig. 18.—John Leake. (From the author's collection.)

an additional number will now be admitted in consequence of many new subscribers and a legacy of three thousand pounds laterly bequeathed to that charity by Mr. Richard Russel." When two or more pupils entered at exactly the same time, the fee was nine guineas each. Of these nine-guinea students Leake states:

> "Such will be deemed *annual Students,* and entitled to the same privileges as *Ten Guinea Pupils,* viz. they will be allowed the *unusual Advantage* of attending patients *singly, and uninterrupted by others,* and consequently have clear and distinct ideas of Labor, from beginning to end.—Hence also, they will obtain true, practical information of its event, whether *natural, difficult,* or *preternatural.* They will likewise see the *Treatment of Diseases, incident to Lying-in Women, and Infants,* a branch of Medical Science essentially necessary to all those who practise Midwifery."

Leake had very clearly in mind the necessity of midwifery embracing the diseases of women and children when he says:

[1] In the announcement for 1792, the number delivered is stated as eight thousand.

As members of the staff, the names of John Leake, James Ford, and Richard Huck Saunders (1720–1785) appeared.

Leake's syllabus contains an outline of twenty-two lectures which include diseases of the newborn, congenital deformities, skin diseases, and a few of the diseases of women unassociated with pregnancy. The pamphlet also contains a number of complimentary letters to Dr. Leake from foreign correspondents. In a postscript to the syllabus, occurs the following:

> "Such Gentlemen as have not sufficient time to receive Instructions in the usual Manner, may be more expeditiously qualified for Practice, by private Instructions, . . . as Dr. Leake's *House Pupils;* the Particulars of which may be known by personal Application."

Leake must be regarded as not only an obstetrician, but a gynecologist, as he devoted much attention to the general diseases of women.

A bibliography of Leake's writings would contain at least a dozen titles, most of which passed through many editions. His influence upon midwifery was noteworthy—not alone due to the establishment of the Westminster Lying-in Hospital. For the period his teaching was sound and his special attention to hemorrhage, convulsions, and instrumental delivery advanced the obstetrical knowledge of the day.

William Osborn was born in London in 1736 and began his medical studies under John Fordyce, subsequently attending the lectures of William Hunter in London and Levret in Paris. He received his M. D. degree from the University of St. Andrews in 1777 and was admitted a licentiate of the College of Physicians in 1783. His death occurred at his residence near Dover in 1808. His association with Thomas Denman in the teaching of midwifery, in which he was eminently successful, began about 1770. He was a thorough believer in the prompt destruction of the fetus in contracted pelves in opposition to cesarean section and in his writings he is unusually emphatic in his attack on the French procedure devised by Sigault—the division of the symphysis pubis.

Thomas Denman (Fig. 19) was born at Bakewell June 7, 1733, where his preliminary education was secured in the public schools. He had acquired from his father, who was an apothecary, a working knowledge of pharmacy and some smattering of medicine. At the age of twenty-one (1754) he went to London and entered upon a student career at St. George's Hospital. His funds running low early in 1755, he engaged as a ship's surgeon and served aboard various ships, sharing in the prize money incident to the sale of captured enemy vessels. In 1770 he resigned his position in the navy and entered upon the practice of medicine in London. He soon renewed a student friendship with William Osborn which had begun some years before at St. George's Hospital and a partnership agreement was entered into for the purpose of giving lectures in midwifery. Fortunately the teaching equipment (manikins, skeletons, etc.) of the late Dr. Thomas Cooper, who had been one of the teachers of midwifery in the lying-in wards of the Middlesex Hospital, was for sale and Denman and Osborn between them somehow supplied the purchase price—£120. Denman's rise in the practice of midwifery was rapid. He was popular with both patients and colleagues and was respected particularly for his dependability. Subsequent to the death of William Hunter he was called to attend many of the "first families" of the

Fig. 20.—The London Lying-in Hospital. Frontispiece of *A Treatise on the Puerperal Fever* by Nathaniel Hulme, 1772.

Name	*Founded*
Middlesex Hospital Lying-in wards	1747
British Lying-in Hospital	1749
City of London Lying-in Hospital (Fig. 20)	1750
General Lying-in Hospital (now Queen Charlotte's Hospital)	1752
The Charity for Delivering Poor Married Women (now Royal Maternity Charity)	1757
New Westminster Lying-in Hospital (now General Lying-in Hospital)	1765
The General Dispensary for Poor Married Women	1785
The Benevolent Institution for Delivering Poor Married Women	1799
Scotland	
Edinburgh Royal Infirmary	1736
Edinburgh Royal Infirmary Lying-in wards	1756
Edinburgh Lying-in Hospital	1784
Edinburgh Maternity and Simpson Memorial Hospital	1793
Glasgow Royal Infirmary	1791
Montrose Royal Infirmary	1782
Aberdeen Royal Infirmary	1739
Dundee Royal Infirmary	1798
Ireland	
Dublin Rotunda Hospital	1745
Belfast Incorporated Maternity Hospital	1794
Cork Lying-in Hospital	1798

The following paragraphs are found in the book of *Laws, Orders and Regulations of the Middlesex Hospital*, promulgated in 1770: (1) the man-midwife eligible for this hospital shall have the degree of doctor of physic; (2) the staff shall meet for consultation every Monday at 11 o'clock in the morning; (3) the physician of the week and the man-midwife shall attend the weekly meet-

Downe in Kent in 1631. Because of the important rôle played by the Chamberlen family in the progress of midwifery of the seventeenth century, a brief sketch of the "practitioner members" of the family is essential.

Peter Chamberlen the Elder was one of the sons of William Chamberlen, a Huguenot refugee who reached England in 1569. Another son, Peter the Younger, was born at Southampton in 1572 and died in London in August, 1626. Both of these sons were members of the Barber Surgeons' Company[1] and became well known as practitioners of midwifery. From the records of the Barber Surgeons' Company, it appears that both Chamberlens were in frequent conflict with that chartered body, as numerous fines were assessed against them for failure to attend meetings. Frequent summons before the College of Physicians[2] resulted from their insistence upon prescribing medicine contrary to the rule of the College.

Aveling[3] notes that the annals of the Barber Surgeons' Company contain numerous references to Peter the Elder:

"1599. March 17.

"This daye Peter Chamberlen and John Johnson paide their severall arrearages of their debtes to this house, that is to saie the said Chamberlen x s., and the said Johnson xx s. whereuppon their severall bondes were delivered them by the Master.

"1599. October 1.

"This daie Mistress Lorde widowe complayned of Peter Chamberlen for not keeping her sonne his apprentice as he ought to doe.

"1601. June 9.

"This daie it is ordered that Peter Chamberlen shall paye to the Maisters and Governors for his lycense of absence xx d.p. quarter.

"1602. March 2.

"Peter Chamberlen the old is graunted lycense of absence from ye lectures provided hee paye to the Maisters of this Company ii s. vi. d. quarterly for the same, the first payments to begin at Midsummer next."

In 1609 Peter the Elder was accused of practicing medicine "illicita mala," and was cited to appear before the president and censors of the College of Physicians, for which offense he was fined forty shillings. In 1610 he was cited, but did not appear. In 1612 he was again before the College for prescribing for Mrs. Miller "in my Lord Mayor's house a certain medicine." On this occasion the College held that the medicine prescribed was improper and as a result his practice was condemned and a warrant was signed for his apprehension and removal to Newgate prison. Under its chartered rights and powers, the College could imprison after trial and judgment, the clause reading:[4]

[1] In England the barbers were first incorporated in 1461 under the reign of Edward IV (1442–1483), and were incorporated with the surgeons as the Barber Surgeons' Company in 1540 under Henry VIII (1491–1547). Under the act of incorporation it was provided that the barbers should confine themselves to minor operations such as blood-letting. The two groups were separated again by George II (1683–1760). In Hamburg the barber surgeons were incorporated in 1452; in France during the reign of Louis XIV (1638–1715).

[2] The Royal College of Physicians was incorporated in 1518 under a charter granted by Henry VIII.

[3] James Hobson Aveling (1825–1892), obstetrician and gynecologist, editor of the *Obstetrical Journal of Great Britain and Ireland*, 1873–1880. His *The Chamberlens and the Midwifery Forceps*, London, 1882, is an exhaustive study of the Chamberlen family.

[4] Aveling, loc. cit.

Cambridge in 1615, and later was enrolled at the universities of Heidelberg and Padua, receiving the degree of M. D. from the faculty of medicine of the latter in 1619. On March 29, 1628, he was elected a fellow of the College of Physicians and Spencer[1] notes that it was ordered that

". . . he be gravely admonished by the President to change his mode of dress and no longer follow the frivolous fashion of the youth at Court, and that he be not admitted until he conform to the custom of the College and adopt the decent and sober dress of its Members."

His formal admission is recorded as having occurred April 7, 1628.

The year 1634 witnessed an attempt on the part of Dr. Peter Chamberlen to establish a Corporation of Midwives with himself as governor. Just how

Fig. 21.—Peter Chamberlen III, not Paul, as stated in the engraved title. (From the author's collection.)

far he had proceeded in the matter cannot be determined. It appears, however, that he had petitioned the King for a charter and that he had been holding at his house monthly meetings of midwives ostensibly for the purpose of giving them instruction. Either misunderstanding his motives, or through fear of his power the midwives (or some of them) determined to resist his plan. At a meeting of the College held August 24, 1634, at which Dr. Peter Chamberlen was present, the registrar records that:[2]

[1] Loc. cit.
[2] Aveling, loc. cit.

And it being true that is reported by the Midwifes, Dr. Chamberlane doth often refuse to come to the poor, they not being able to pay him according to his demands and for the rich he denies them his help until he hath first bargained for great rewards which besides that they are in themselves dishonest covetous and unconscionable courses, they are also contrary to the laws and statutes of our College to which by Oath he is bound."[1]

The petition, having been referred to the Bishops by the King in a special order, a hearing was held in the Archepiscopal Palace of Lambeth on October 22, 1634, before the Archbishop of Canterbury[2] and the Bishop of London. The King's reference of the petition to the Bishops lay in the power of the Bishops to license midwives, hence changes in procedure might properly be brought before them. In the pleadings of the midwives before the Bishops, it was argued that:

"Mr. Chamberlane Dr. of phisicke practic̃oner in Midwifery unto whom all yo^{r} petic̃oners have and do apply themselves upon occasion in unnatural and dangerous birthes as a phisition-more peculiarly applying himself to the practise thereof then others but deny a necessity of dependance upon him otherwise then in the cases before menc̃oned they being authorized by the power of the ecclesiasticall Courts to practise the said p(ro)fession to whome (if they err in their duty) they are liable to give accompt of their proceedings and to answear such complaints as shall be laid against them."[3]

The midwives further stated that:

"Neither can Dr. Chamberlane teach the art of Midwifery in most births because he hath no experience in itt but by reading and it must bee continuall practise in this kind that will bringe experience, and those women that desire to learn must be present at the deliv'y of many women and see the worke and behavio^{r} of such as be skilfull midwifes who will shew and direct them and resolve their doubts.

"And further Dr. Chamberlane's work and the work belonging to midwifes are contrary one to the other for he deliv's none without the use of instruments by extraordinary violence in desperate occasions, w^{ch} women never practised nor desyred for they have neither parts nor hands for that art.

"And for shewing or reading of Anatomy to them that can doe but little good to better their experience or judgment, except it be when a woman is with child or instant upon her delivery, and anatomies are made of persons w^{ch} suffer by the law, now women p^{r}gnant during their p^{r}gnancy and their lying are exempt for that time, and so cannot be of use in the particular above-mentioned to them, and they have bookes in English of Anatomie w^{ch} will direct them better (most of them being able to read) then his learned lectures."

At the conclusion of the hearing, the Bishops condemned Dr. Chamberlen's action and ordered

". . . That the said Dr. Chamberlaine should forthwith bee a Suitor to the Lord Bishopp of London for a Lycence to practize the Art of Midwifery. . . ."

Probably as a result of his failure to incorporate the midwives and harboring a feeling of injustice for the defeat of his efforts toward improving the midwives through education and supervision, he published some years later a pamphlet, autobiographical in character, entitled *A voice in Rhama: or, the Crie of Women and Children* (1647). In this pamphlet he scourges the ignorant midwives:[4]

[1] Aveling, loc. cit.
[2] William Laud, Archbishop of Canterbury, 1633–1645.
[3] Aveling, loc. cit.
[4] Aveling, loc. cit.

Dr. Peter Chamberlen's tomb is in Woodham Mortimer Churchyard. The biographical portion of his epitaph relates that:[1]

"The said Peter Chamberlen took y[e] degree of Doctor in Physick in severall Universities, both at home and abroad and lived such above three score years, being Physician in ordinary to three Kings and Queens of England, viz., King James and Queen Anne, King Charles y[e] First and Queen Mary,[2] King Charles y[e] Second and Queen Katherine,[3] and also to some foreign Princes, having travelled to most parts of Europe, and speaking most of the languages."

Hugh Chamberlen the Elder, son of Dr. Peter Chamberlen, was born in the Parish of St. Anne, Blackfriars, in 1630. He was the eldest of Dr. Peter Chamberlen's children and was named for his maternal grandfather, Sir Hugh Myddelton.[4] He was appointed physician-in-ordinary to the Queen[5] in 1673. As Aveling notes, nothing can be determined with certainty as to Hugh Chamberlen's education. He must, however, have been an apprentice to his father in the practice of midwifery. Certain it is that he carried on the tradition of the Chamberlen family as it is recorded in Mauriceau's *Observations sur la Grossesse et l'Accouchement*[6] that in August of 1670 he used his forceps on a patient of Mauriceau's. Mauriceau relates that he had a difficult case of labor in a thirty-eight-year-old primipara with a deformed pelvis. It seems that Chamberlen had arrived in Paris several months earlier and had let it be known that he possessed a secret means of facilitating deliveries, otherwise impossible. On this occasion Mauriceau expressed the opinion that the patient could not be delivered, but Chamberlen affirmed that he could deliver the woman safely in a quarter of an hour. After three hours he desisted and twenty-four hours later the patient died undelivered. Mauriceau states that the autopsy disclosed that the uterus had been torn and perforated in various places.

Hugh Chamberlen translated Mauriceau's text into English and in so doing made a substantial contribution to the progress of midwifery in England. This book was without question the most practical, explicit and accurate of the then known treatises on midwifery and contained so many advances over its predecessors that in the hands of English physicians, surgeons and midwives it not only improved the practice of midwifery but paved the way for further advances. Lee says:[7]

"The translation of Mauriceau's work into English, soon became the text-book of all who were engaged in the practice of midwifery in this country, and from this time may be dated most of the improvements in it which subsequently took place in the course of the following century."

The first edition appeared in 1672, and at least eight subsequent editions are known. The publication of this translation did much for Chamberlen and

[1] Lee, loc. cit.

[2] Henrietta Maria (1609–1666), daughter of Henry IV (1553–1610) of France and Marie de' Medici (1573–1642).

[3] Catherine of Braganza (1638–1705).

[4] Sir Hugh Myddelton (1560?–1631), a projector of the new River; traded as a goldsmith, banker, and clothmaker.

[5] Queen Catherine, wife of Charles II.

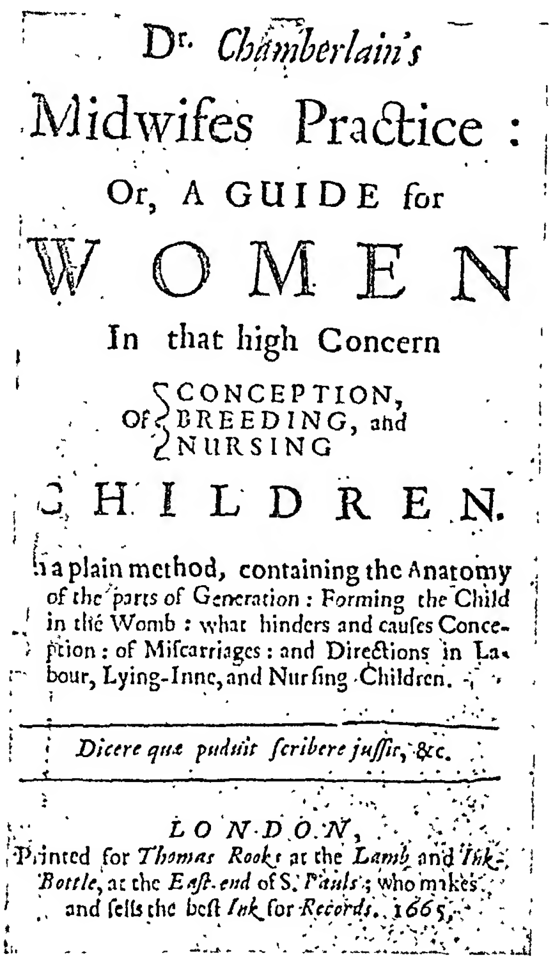
[6] Paris, 1694. Observation xxvi.

[7] Loc. cit.

(not wanting ignorance, nor impudence) presume to take upon them this Mysterious Office, do bring great danger, and oftentimes death upon such as they rashly undertake, being unskilled in the *Anatomical parts*. . . ."

The author admits that he knew of the existence of

". . . a Small treatise of this Nature, composed of Carping Nonsense, and made as if it were to rail at the Learned, rather than any wayes to instruct the Ignorant. . . ."



Dr. *Chamberlain's*

Midwifes Practice:

Or, A GUIDE for

WOMEN

In that high Concern

Of { CONCEPTION, BREEDING, and NURSING

CHILDREN.

In a plain method, containing the Anatomy of the parts of Generation: Forming the Child in the Womb: what hinders and causes Conception: of Miscarriages: and Directions in Labour, Lying-Inne, and Nursing Children.

Dicere quæ puduit scribere jussit, &c.

LONDON,

Printed for *Thomas Rooks* at the *Lamb* and *Ink-Bottle*, at the *East-end* of S. *Pauls*; who makes and sells the best *Ink* for *Records*. 1665.

Fig. 22.—Facsimile of the title page of *Dr. Chamberlain's Midwifes Practice*, London, 1665. The preface to this volume is signed "P. C."

Actuated, as he suggests, by the desire to confound the writer of such "carping nonsense," Chamberlen defends his own publication as follows:

"These motives I say induced me to unlock the most abstruce Cabinet of nature, to untie her gordion knots in her most principal Fabrick; and in this ensuing Treatise, as with a Clew of Thread, lead you through her most *Meandring* Labyrinths in the Conception, Procreation and Birth of Mankind: Having distinctly and plainly laid open the *Anatomicall* part thereof; wherein it concerns not only every one in particular that would know themselves to be experienced; but most especially such as take upon them the most venerable *Practice of Midwifery:* For a *Midwife* that is ignorant hereof, is no more fitting for that Faculty, then a blind man to judge of Colours: . . . . I have faithfully bestowed my pains, reap you the profit."

war with the College of Physicians ceased and Hugh Chamberlen, Junior, lived and died an honored member. A handsome monument to his memory was erected in Westminster Abbey by Edmund, Duke of Buckingham, and the epitaph inscribed thereon is the composition of his friend, Atterbury, Bishop of Rochester.[1]

Just why some one of the Chamberlens did not publish the "secret" of the forceps can only be conjectured. The nearest Hugh Chamberlen, Senior, came to an explanation is found in "The Translator to the Reader," prefixed to the second edition of his translation of Mauriceau's work. In this he says:

> "I will now take leave to offer an Apology for not publishing the Secret I mention we have to extract Children without Hooks, where other Artists use them, which is, that there being my Father and two Brothers living, that practise this Art, I cannot esteem it my own to dispose of, nor publish it without injury to them; and think I have not been unserviceable to my Country, altho I do but inform them that the forementioned three Persons of our Family, and my Self, can serve them in these Extremities, with greater safety than others."

His reference to the forceps is found in this same "epistle to the reader":

> ". . . . my Father, Brothers, and my Self (tho none else in *Europe* that I know) have, by God's Blessing, and our Industry, attained to, and long practised a way to deliver Women in this case, without any prejudice to them or their Infants; tho all others (being obliged, for want of such an Expedient, to use the common way) do, and must endanger, if not destroy one or both, with Hooks. By this manual Operation may be dispatched, (when there is the least difficulty) with fewer pains, and in less time, to the great advantage, and without danger, both of Woman and Child."

It is little short of remarkable that the secret of the forceps could have been kept for so long a period when one considers the numerous applications of the instruments that must have been made between 1600 and 1725. As we have noted they were carried to France, Holland, Denmark, and Sweden.

In defense of the "apology" of Hugh Chamberlen, Senior, it may be said that the age was one of many secret remedies. The only members of the family who identified themselves with the College of Physicians were Dr. Peter Chamberlen and Dr. Hugh Chamberlen, Junior. Undoubtedly the College was aware of the existence of the forceps and equally aware that their construction and mode of use was held inviolate by their two members. The numerous quarrels of the College with Dr. Peter Chamberlen were in no single instance related to the forceps. The College of Physicians, therefore, retained in membership at least two individuals who harbored a medical secret. Family tradition, pride, and the "trade" instinct no doubt prevailed.[2]

According to Robert Wallace Johnson[3] he had in his possession (1769) a pair of forceps that had belonged to Mr. Drinkwater, surgeon and man-midwife at Brentford, who began practice in 1668 and whose death occurred in 1728. Johnson gives no data relative to Drinkwater's practice and cites no instance in which it is known positively that Drinkwater used the forceps.

[1] Francis Atterbury (1662–1732), man of letters, politician and bishop of Rochester (1713–1722).

[2] Illuminating articles on the Chamberlen family may be found in the *Liverpool Medico-Chirurgical Journal* (1916) by H. Drinkwater; the *Scottish Medical and Surgical Journal* (vol. vii, 1900) by A. R. Simpson; and the *Journal of Obstetrics and Gynecology of the British Empire* (vol. xxii, 1912) by Alban Doran.

[3] *A New System of Midwifery, in Four Parts; founded on Practical Observations.* London, 1769.

Fig. 23.—Jean Palfyn. Frontispiece in his *Anatomia chirurgica,* Venezia, 1758.

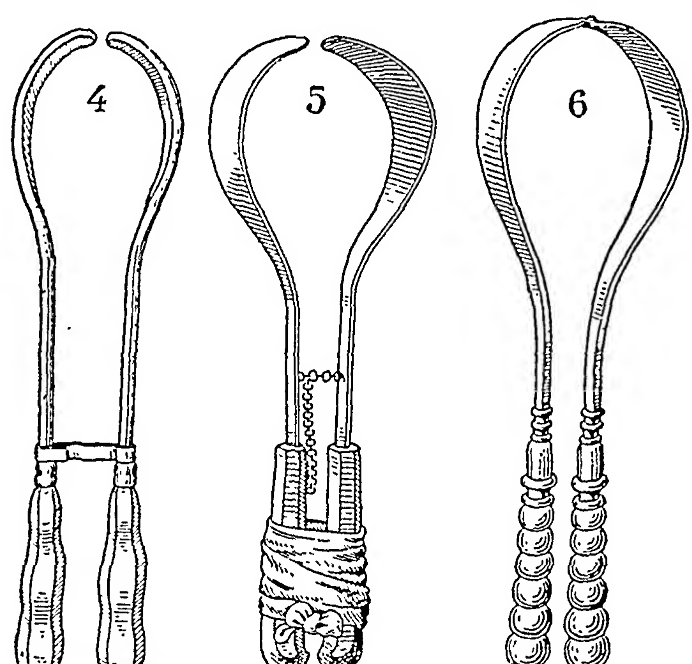


Fig. 24.—"Mains de Palfyn." From *Accoucheurs et sages-femmes célèbres* by G. J. Witkowski, p. 135. It is probable that the linking of the handles as shown (4–5) was a later improvement, possibly by Grégoire.

Long before the recovery of Chamberlen's instruments from their hiding place (1813), midwifery forceps had become generally known to the profession. In fact, the forceps of Palfyn, Drinkwater, Giffard, Chapman, Pugh and Dusée were known and used before the middle of the eighteenth century.

The forceps of **Dusée** played such an important part in the introduction, through Smellie, of the short straight forceps that no little credit must attach to the name of Dusée. Alban Doran in an admirable article *Dusée, De Wind and Smellie: An Addendum*[1] includes some observations on Dusée made by Paulus De Wind[2] when in Paris in 1734. De Wind

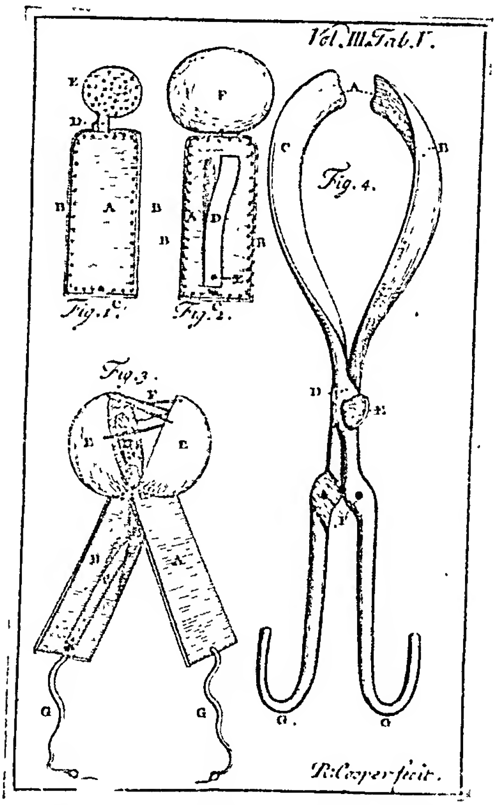


Fig. 26.—Engraved plate showing Dusée's forceps (Fig. 4) accompanying the article by Alexander Butter in Med. Essays & Obs. Edin., 1735, vol. III.

relates that he had journeyed to Paris for the purpose of acquiring a knowledge of midwifery and had attended some of the lectures of the "renowned obstetrician Grégoire":[3]

[1] *Journal of Obstetrics and Gynaecology of the British Empire*, vol. xxii, 1912.

[2] Paulus De Wind was a lecturer on anatomy, surgery and obstetrics, and practiced as a lithotomist and obstetrician in Middleburg, province of Zealand, in the United Netherlands.

[3] Grégoire the Elder founded in 1720 the first obstetrical clinic for teaching purposes at the Hôtel Dieu. Both Grégoires, father and son, taught midwifery and are said to have modified Palfyn's forceps, closing the handles and adding a "kind of lock." Baas (*Outlines of the History of Medicine and the Medical Profession.* Translated by H. E. Handerson, New York, 1889) attributes to them the addition of the fenestrated blades and says that the Grégoire forceps were later described in Germany in 1746 by P. A. Bohmer (1717–1789) of Leipzig.

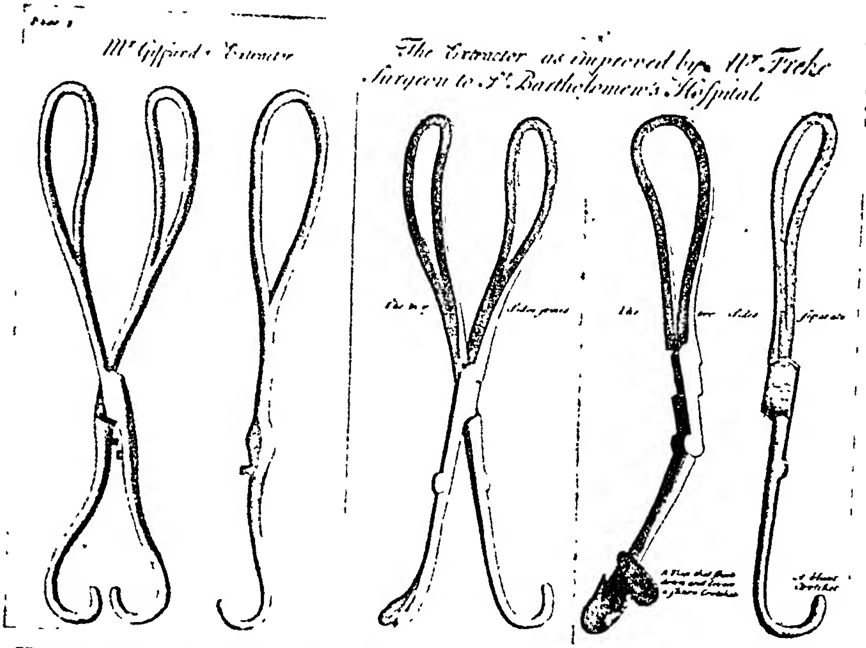


Fig. 27.—Engraving of forceps. Plate 1 in *Cases in Midwifry* by William Giffard, London, 1734.

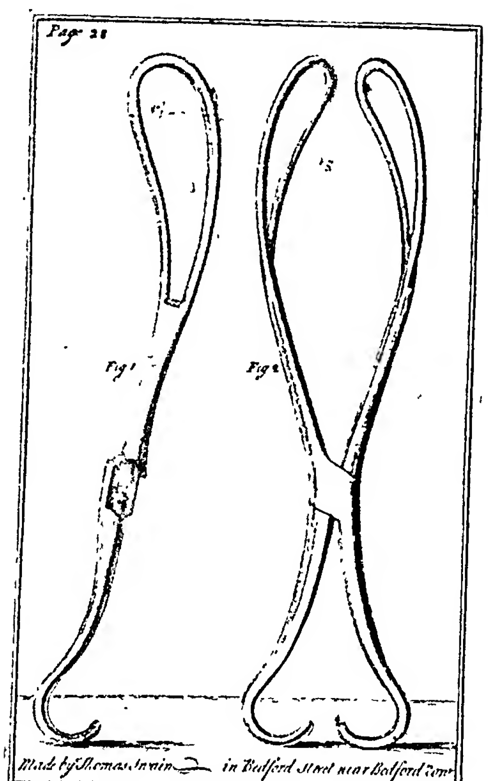


Fig. 28.—Chapman's forceps. From engraved plate accompanying the second edition of *A Treatise on the Improvement of Midwifery* by Edmund Chapman, London, 1735.

Edmund Chapman.—In 1735 coincident with the publication of Butter's essay, there appeared the second edition of Edmund Chapman's *A Treatise on*

oftentimes slipped, and when I expected the Head of the Child, I have been deceived, and found the Handle Part come close, the Instrument only in my Hands, and the Work all to do over again."

Chapman observes that the instrument employed without the screw rarely if ever slips, and refers to Case XIV of Giffard's, in which Giffard complained that his extractor slipped.

Relative to his discovery of the forceps Chapman says

"I do confess, that I came by this Hint and Improvement by mere *Accident*."

In his early years he seldom used the forceps and for a space of ten years did not use them once. Then he caused a pair of forceps to be made of much stiffer metal and, happening to lose the screw, found that the instrument served much better without it or the two parts being "fixt."

"All I can say in Praise of this noble Instrument, must necessarily fall short of what it justly demands."

Butter refers to Chapman's forceps with the statement:

"I think Mr. *Chapman* is in the right to desire the *Axis* not to be put in, for it is very troublesome to take out and put in again, when any of the Blades quit their Hold, and the Instrument can easily be managed without it, in extracting the Child in the Manner mentioned; . . ."

In January of 1747 **André Levret**[1] (1703–1780) (Fig. 29) presented to the Royal Academy of Surgery of Paris, a new curved forceps (Fig. 30) contrived for disengaging the fetal head "empacted in the pelvis." In his treatise *Observations sur les Causes et les Accidens de Plusieurs Accouchemens laborieux avec des Remarques sur ce qui a été proposé ou mis en usage pour les terminer;* etc.[2] Levret clearly proved the utility of the pelvic curve and showed how impossible it is to affix straight forceps and to make traction that will be of advantage unless the head is low. Levret's demonstration antedates by seven years the published report of Pugh's[3] forceps with the pelvic curve, although Pugh stated that he invented his forceps in 1740. Johnson says[4] of Levret's forceps:

"These forceps are an improvement on the Chamberlen's in some respects, seeing they are somewhat flatter and smoother on the outsides; their clams too are shorter, and what is more, they are curved, which is the first hint of this kind (so far as I know) that has ever been published."

Benjamin Pugh's treatise is of special interest because of the author's relation to the forceps and the fact that he was the earliest, with the exception of Levret, to develop the pelvic curve. In his preface he says:

[1] André Levret, famous French obstetrician, was accoucheur to the Dauphiness, mother of Louis XVI (1754–1793). He was also a surgeon of sufficient eminence to be elected a member of the Royal Academy of Surgery of Paris. It is recorded that when he was called to court to attend the Dauphiness, the Dauphin said to him, "You must be pleased, M. Levret, to deliver the Dauphiness. That will make your reputation," to which Levret replied, "If my reputation were not already made, I should not be here." (Unsigned article in *Brit. Med. Jour.*, vol. i, 1912, p. 746.)

[2] Paris, 1747.

[3] *A Treatise of Midwifery, Chiefly with Regard to the Operation.* London, 1754.

[4] Loc. cit.

liveries, without opening one Child's Head for these fourteen Years past; and I doubt not but every Operator will be soon sensible of their Advantages. The Curved Forceps I invented upwards of fourteen Years ago,[1] made me by a Man of Mr. Archers, Cutler, now living in *Chelmsford*. The Preference between them, and the common Streight Forceps, in every Respect, is great."

Johnson says[2] of Pugh:

"Mr. Pugh, a surgeon at Chelmsford in Essex, published a treatise on midwifery in 1754, with figures of curved forceps, which was first shewn to me by Mr. Cargill, in Lombard-street, in 1761; . . . Before this time, I knew nothing of either this gentleman or of his productions: . . . and as to his forceps, they appear to me preferable to any of those which were published before them; . . ."

Pugh was led to the invention of the pelvic curve (Fig. 31) to facilitate delivery in those cases that have been in labor for many days: He says:

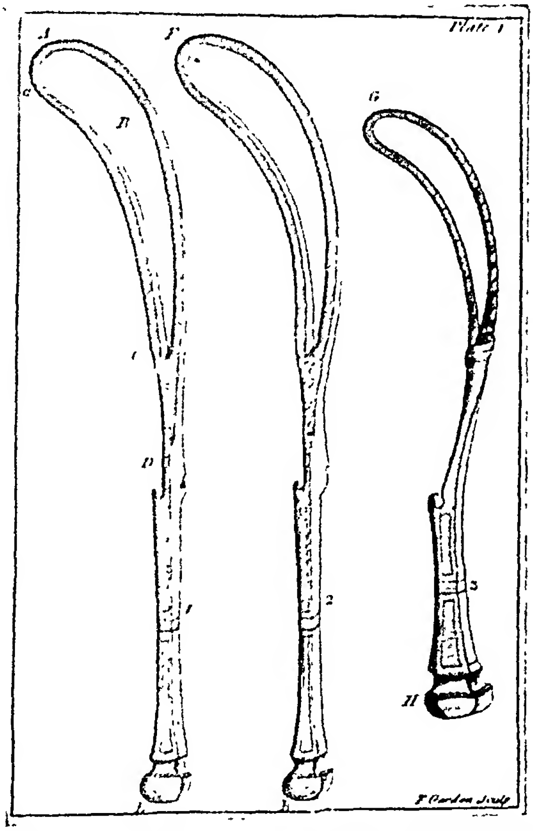


Fig. 31.—Engraving of forceps. Plate 1 in *A Treatise of Midwifery* by Benjamin Pugh, London, 1754.

". . . . if sent for after a Midwife, who has kept the poor Woman a long Time (perhaps some Days) and till her Strength is almost exhausted, and perhaps most or all the above bad Symptoms attending; the Parts also dry, and the Womb tightly compressing the Child; I say, all these Things meeting together, you will be sufficiently convinced that the poor Patient is not able to undergo the Fatigue of turning the Child, but must have Help by some other Means, or lose her Life. This is a Case that requires the Help of Instruments, and that put me upon inventing my Curve Forceps, ...")

[1] This would date Pugh's discovery of the pelvic curve about 1740.

[2] Loc. cit.

It is interesting to note that in considering the leather covering of Smellie's forceps Johnson suggests that the forceps

". . . be newly covered every time of using, for by this extremely spongious substance (namely, what is called wash-leather) humours which are infectious may be absorbed, and conveyed from one patient to another."

He suggests that if Morocco leather is used, the forceps may be washed very clean with soap and water after each time they are used:

". . . rather than neglect this, I could wish them not to be covered at all."

John Burton[1] justly criticizes Smellie's suggestion that the blades of the forceps be covered with leather.

". . . some Part of the Blood and Waters must be sucked up by the Leather, and lodge betwixt it and the Steel-work, where it will corrupt and stink, let the Maker be as careful as he will in covering it."

In spite of the fact that he criticized Smellie's forceps, Burton evidently used the straight forceps, as would appear from his description of the introduction of the blades:

". . . the Operator . . . must take one Side of the Forceps (being warmed and oiled) in one Hand (the left, for Instance) and by the Help of the other, introduce it into the *Vagina* on the right Side, along the Palm of the Hand, having its concave Surface next the Child's Head, thrusting it forward gently, till he finds the End of it has gone as far as the Neck of the Child, but on one Side of the Head, which he will know by the Ear: In this Position, the Handle of the Instrument, will be at the left Side, where it must be held by the left Hand, not suffering it to move either up or down; which it will be apt to do: The other Side is to be introduced by the *right Hand only* at the left Side of the *Vagina*, opposite to the other, and the Handles intersecting, may be fixed at the Articulation, and held with one Hand, while the Operator examines with the other, to find if the Ends be right placed; which done, he must turn the Face of the Child into its natural Position, and pull by the Handles with as much Force as may be necessary, till the Head comes forth; and then, quitting the Instrument, he must take hold of the Head, and bring forth the Child, as in a natural Delivery."

Burton describes a new forceps which he invented, the use of which, he says, is far less prejudicial either for the woman or the child and is far more commodious for the operator (Fig. 32). Burton claims for his own instrument that the wings can be so adjusted as to fit the child's head exactly and that through the screw in the handle they can be so regulated as to pressure as to give a much firmer hold. A study of the blades of Burton's forceps would lead one to believe that practical use of such an instrument would be well-nigh impossible. Although the blades were detachable and could be placed on either side of the child's head, the reattachment of the blades to the handle must have been a difficult task. Strangely enough no mention of the use of Burton's forceps appears in any contemporary or succeeding author, and as Doran indicates,[2] it is probable that Burton found his own forceps unworkable

[1] *An Essay towards a Complete New System of Midwifry, etc.* London, 1751.
[2] *Burton: His Forceps and His Foes.* By Alban Doran. *Journal of Obstetrics and Gynæcology,* vol. xxiii, 1913.

Pugh, Levret, and Smellie within a few years of each other independently developed the pelvic curve. If we may rely upon Pugh's statement as to the date of construction of his forceps (1740) he would be entitled to priority of invention and use, but not of publication. Hence Levret must stand as the originator of this important improvement. Smellie, according to his own statement, had employed his forceps with the pelvic curve several years prior to his published account (1754).

The history of obstetrical forceps may be said to end practically with Smellie and Levret. While scores of models have followed since their day, each with some minor improvement, no suggestion of real moment appeared until the demonstration by Tarnier before the Paris Academy of Medicine on January 24, 1877. That day marked another distinct advance in the development of this important instrument.

FRENCH MIDWIFERY FROM PARÉ TO BAUDELOCQUE

Ambroise Paré (1510–1590) created a new epoch in surgery and greatly advanced the science of midwifery. For the first time observation and experiment at the hands of this eminent teacher and his pupils struggled for dominion over tradition and authority. Advances in surgery in the Middle Ages may be counted as nonexistent with the possible exception of those emanating from Guy de Chauliac (1300–1370) whose writings Paré studied during his apprenticeship. Paracelsus (1493–1541) had burst meteor-like upon the medical horizon and had begun his iconoclastic but necessary rôle. Nevertheless, Paré was to save much that was good in the older writers, retain much that was bad and on this foundation make outstanding and distinct advances.

For three years Paré lived at the Hôtel Dieu as a resident surgeon where he had ample experience with surgical and medical conditions and where he made numerous postmortem examinations. Leaving the hospital, he plunged into army medical service and after much experience in the field was qualified in 1541 as a master barber-surgeon at the age of thirty-one. His career as an army surgeon continued for many years, interspersed with periods of private practice. Prior to 1541 he had made two notable discoveries: First, that hot oil was not good for gunshot wounds; and, second, that the ligature was adapted to the arrest of hemorrhage. In 1554 he was admitted to the confraternity of St. Cosmo,[1] then termed, by the members, the "Royal College of Surgeons," and in 1569 began his long controversy with the medical faculty of Paris which opposed his numerous surgical advances. He was surgeon to four kings: Henry II (1519–1559) and his three sons in succession —François II (1544–1560), Charles IX (1550–1574) and Henry III (1551–1589). Just when his interest in midwifery began is not known, but it was probably aroused in the Hôtel Dieu where the abominable practices of many of the midwives must have filled him with horror. At any rate most of his pupils were instructed in midwifery as well as surgery and his second published volume, *A Short Compendium on the Chief Facts of Anatomy*, etc., published in 1550, contains a treatise of ninety-six pages devoted to obstetrics. Podalic version, though mentioned by Celsus, had been well-nigh forgotten

[1] St. Cosmo and St. Damien were two brother physicians, born in Arabia in the third century, who were put to death because of their belief in Christianity. They were the patron saints of the surgeons.

of our discussion we must regard his two early works,[1] *De l'Heureux Accouchement* and *De la Nourriture et Gouvernement des Enfants* (Paris, 1609) (Fig. 33) as of outstanding importance.

The first section of *De l'Heureux Accouchement* contains twenty-eight chapters on pregnancy, the second section twenty-eight chapters on delivery, and the third section forty-six chapters on diseases of women dealing with gynecological conditions. There are in addition fifty-two chapters on diet, the care of the newborn, children's diseases, and the diagnosis of pregnancy.

Chapter 11 of the second section opens with the statement that women with an excessive flow of blood or convulsions at the onset of labor must be delivered without delay. Guillemeau describes in great detail the mechanism for prompt delivery: the position in which the patient shall be placed, the duties of the assistants, and notes that the patient must not be permitted to observe the manipulations of the obstetrician. He says:

> "Then the surgeon slides his hand, oiled, into the orifice and removes any clots of blood. He then determines whether the cervix is sufficiently dilated to introduce his hand and to turn the child if necessary. If the cervix is not dilated enough, he introduces his hand covered with butter or pomade and as gently as possible dilates it. If the bag of waters is intact, he breaks it. If the child comes head first, he gently turns it, to locate its feet. Then finding one foot, he pulls it gently, and ties a band of ribbon around it, leaving the end of the ribbon hanging out. He then pushes the child back a little way in order to locate the other foot which is done by sliding the hand along the thigh of the child. Then having found both the feet, he draws on them together, gently, giving the mother time to rest and commanding her to bear down when she feels a pain. Thus the surgeon delivers the child into a warm piece of linen which he holds ready to receive it. It is very important to see that the stomach, chest and face of the child are turned down, about which more is said in another chapter."

After emphasizing and reiterating the importance of promptness in dilating the cervix and delivering the child if conditions demand, Guillemeau gives several case histories to emphasize his points. The first case mentioned was probably that of a low implantation of the placenta.

> "In 1599, Mademoiselle[2] Simon,[3] who is still living (1609), daughter of Monsieur Paré, Medical Adviser and First Surgeon to the King, was ready to deliver, when she was surprised by a great flow of blood and attacked by syncope. She was attended by Madame la Charonne for midwife, and by Monsieur Rigault and M. Haultin. The author was then called in. Her pulse was very weak, her voice feeble, her lips blue. The author decided that she was in great danger of her life and that only one thing could save her, and that

[1] Both were published in London in 1612 under the following titles: *Child-birth, or the happy deliverie of women, wherein is set downe the government of women in the time of their breeding childe, of their travaile, both naturall and contrary to nature, and of their lying in. Together with the diseases which happen to women in those times, and the means to helpe them; to which is added a treatise of the diseases of infants and young children, with the cure of them.*

The nursing of children, wherein is set downe the ordering and government of them from their birth; together with the means to helpe and free them from all such diseases as may happen unto them.

[2] At the time this account was written, the term "mademoiselle" was applied to a young married woman whose husband was of less than knightly rank.

[3] Stephen Paget in his *Ambroise Paré and his Times* (London, 1903) notes that Anne, the daughter of Ambroise Paré and his second wife, Jacqueline Rousselet, "was married July 4, 1596, to Henri Simon, who became one of the King's Council, and held a high position in the Government. In 1599, Anne nearly died in child-birth. Her life was saved by Haultin, by a method that her father had taught him. Anne and her husband were alive, but without children, in 1616."

of its material and the clarity of its literary style, was very popular in Germany and England[1] as well as in France.

Loysa Bourgeois (1563–1636) (Fig. 34) was the first female midwife whose reputation was not only established throughout her native land, but spread to the centers of medical learning throughout continental Europe. She was the first midwife to publish a work on obstetrics.[2] The first edition appeared in 1609; the second in 1617; the third in 1626, considerably enlarged; and the sixth in 1634 contained an appendix: a "collection of secrets" of Loysa Bourgeois. Editions of this popular manual appeared as late as the early part of the eighteenth century. In her "collection of secrets," the medical treatment of many diseases is outlined. Although there are no descriptions

Fig. 34.—Loysa Bourgeois. From *Remarks on the Writings of Louyse Bourgeois* by Hunter Robb, *Johns Hopkins Hosp. Bull.*, 1893, vol. iv.

of definite disease entities, symptoms are mentioned, and the treatment prescribed. For example: headache, hydrophobia, catarrh, cough, pleurisy, fevers, diseases of the liver, diseases of the kidney, dropsy, stone in the bladder, flux of the belly, neuralgia, tumors, and ulcers are considered as diseases. In the chapters devoted to diseases of women, Loysa Bourgeois, true to her feminine instincts, writes of cosmetics, outlines a plan for removing smallpox pits, for doing away with warts, moles, freckles, and for beautifying the hands. Sterility, which the author states is caused by too great humidity of the uterus,

[1] In England it was well enough thought of to form the substance of Richard Banister's (d. 1626) *One Hundred and Thirteen Diseases of the Eyes and Eyelids* (1622), which seems to have been the earliest general work on eye diseases in the English language.

[2] *Observations diverses, sur la stérilité, perte de fruict, foecondité, accouchements, et maladies des femmes, et enfants nouveaux-naiz.* Paris, 1609. A German translation was published in 1628.

"If the woman hath had hard labour, presently after she is delivered they ought to cast her into the skin of a sheep flead alive, and put it about her reins hot; and take the skin of a Hare flead alive, and then cut the Hares throat and rub the skin with the blood, and apply it as hot as may be to her belly."

Loysa Bourgeois was born at Faubourg, near Paris. She was a member of a middle class family whose residence was adjacent to that of a certain barber surgeon, named Martin Boursier, who had studied as a pupil-assistant with Paré for many years. Surgeon Boursier became attracted to Loysa who manifested great interest in his profession and their marriage followed. Subsequent to the birth of their first child, Loysa practiced midwifery among the poor of her neighborhood having received certain instructions from her husband. Her natural aptitude for midwifery early manifested itself. Although she was probably more skilful than the best of the female midwives of the period, the guild of midwives vigorously but ineffectually opposed her application for a license, no doubt fearing the influence in her favor that Paré and the surgeons had already begun to exert. At the age of thirty-six, she was called to attend Marie de' Medici (1573–1642), wife of Henry IV (1553–1610). Of the birth of the future Louis XIII, at Fontainebleau, September 17, 1601, she wrote a *"récit véritable."*[1] There were present on this occasion as consultants M. de la Rivière, first physician of the king; M. de Laurens, first physician of the queen; M. Herouard, also physician of the king, with M. Guillemeau, surgeon of the king. From her "recit" the following is excerpted:

"The obstetrical chair was also brought in; it was covered with crimson velvet. About 4 o'clock in the morning a great colic, mingling itself amongst the travail of the queen, gave her terrible pain without helping her along. From time to time the king made one of the doctors come to see the queen and speak to me so that I might know what was taking place. The colic made the queen suffer more than the travail, and even kept her from it. The doctors asked me, 'If this were a woman and you were alone with the case, what would you do?' I proposed to them some remedies which they ordered at once from the apothecary, who proposed to them others in the Italian style,[2] which he said in similar cases had done much good. Knowing the great zeal which the apothecary had in the service of her majesty, and knowing that if the remedy did not do all the good he claimed for it, it could not do her any harm, I made no protest, so they gave it to her."

Reliance upon the polypharmacy of the period may be noted from the following:

"To combat the insupportable colic, it was necessary to use a great many remedies. To these the queen made no resistance; for as soon as the king or doctors talked to her, she was content, and took them no matter how disagreeable they were. That is why many

[1] *Récit véritable de la naissance de messeigneurs et dames les enfans de France, avec la particularitez qui y ont esté.*

See *Nouvelle Collection des Mémoires relatifs à l'histoire de France.* By J. F. Michaud et J. J. F. Poujoulat, Paris, 1857.

An Old Midwife's Tale. By Walter Allport. *The Chicago Medical Recorder,* vol. xxxiv, 1912.

[2] Marie de' Medici was an Italian, the daughter of Francis de' Medici, Grand Duke of Tuscany.

female midwives. It was not, however, until the seventeenth century that serious study was devoted to this important branch of medicine and in contrast with the names of other writers on the subject, that of Mauriceau stands unrivalled.

François Mauriceau was born in 1637 and died in 1709. Little is known of his early training, but his extensive practice in midwifery, both private and in the Hôtel Dieu of Paris (then the greatest establishment in Europe for

Fig. 35.—Engraved frontispiece of the *Traité des maladies des femmes grosses* by François Mauriceau. Third edition, Paris, 1681.

lying-in women), fully qualified him to lay down rules of procedure formulated as a result of his wide experience. André Levret says that Mauriceau "drew from the cradle" the art of midwifery.

Hugh Chamberlen (b. 1630), who, with other members of his family possessed the secret of the obstetrical forceps, translated Mauriceau's *Traité des maladies des femmes grosses*[1] (Paris, 1668) (Fig. 35) into English in 1672.

[1] The complete title translated is *The Diseases of Women with Child, and in Child-bed; with a True Method of assisting them in their Natural Labours; and the Means of remedying all those contrary to Nature; and the Diseases of Infants New-born. Likewise an exact Description of all the Parts of a Woman destin'd to Generation; together with many Figures suitable to the Subject.* The approbation of the four Sworn provosts and wardens of the Master-Chirurgeons of Paris is dated March 15, 1668.

In discussing "unnatural" deliveries, Mauriceau notes that Galen and many other authors have greatly wondered at the ability of the child's head to pass the pelvic bones and that many of the authors believed that the os pubis is separated to enlarge the passage and that therefore a woman "a little antiquated" suffers more in her first labor than others because the os pubis cannot be so easily separated. He quotes Paré to the effect that in a woman who had suffered death by hanging fourteen days after she had been delivered, he (Paré) found the os pubis separated in the middle to the breadth of half a finger and the os ilia disjointed from the sacrum. Without rancor Mauriceau makes it clear that Paré must have been mistaken.

Mauriceau's description of his method of delivery when the feet are brought down follows with unusual fidelity the classic description earlier quoted from Guillemeau:

"As soon then as the Chirurgeon hath found both the Child's Feet, he may draw them forth; holding them together, he may bring them by little and little in this manner, taking afterwards hold of the Legs and Thighs as soon as he can come at them, and drawing them so till the Hips be come forth: the whilst let him observe to wrap the parts in a single Napkin, to the end that his Hands, being already greasy, slide not on the Infant's Body, which is very slippery, because of the viscous humours which are all over it, and hinder that one cannot take good hold of it; which being done, he may take hold under the Hips so to draw it forth, to the beginning of the Breast, and then the Child's Body, which he may then easily find, and be careful that the Belly and Face be downwards, lest being upwards, the Head be stopt by the Chin over the Share-bone; wherefore if it be not so, he must turn it to that posture; which is easily done, if taking hold on the Body, when the Breast and Arms are forth in the manner we have said, he draws it, with turning it in proportion, on that side which it most inclines to, till it be as it should be, that is, with the Face downwards; and having brought it to the Shoulders, let him lose no time (desiring the Woman at the same time to bear down) that so in drawing, the Head at that instant may take its place, and not be stopt in the passage."

Should difficulty be encountered in delivering the after-coming head, Mauriceau continues:

"There are indeed some Children that have their Head so big, that when the whole Body is born, yet that stops in the Passage, notwithstanding all the care to prevent it: in this case he must not endeavour only to draw forth the Child by the shoulders, lest he sometimes separate the Body from the Head, but he must disengage it, by little and little, from the Bones in the Passage with the fingers of each Hand, sliding them on each side opposite the one to the other, sometimes above and sometimes under, until the work be ended, endeavouring to dispatch it as soon as possible, lest the Child be suffocated; as it will certainly be, if he should remain long in that posture; which being well and duly effected, he may soon after fetch the After-birth as above directed."

Although not alone in recommending the use of the examining finger yet Mauriceau shares the responsibility for digital vaginal examinations on the part of the midwives, for we have ample evidence that his directions were slavishly followed:

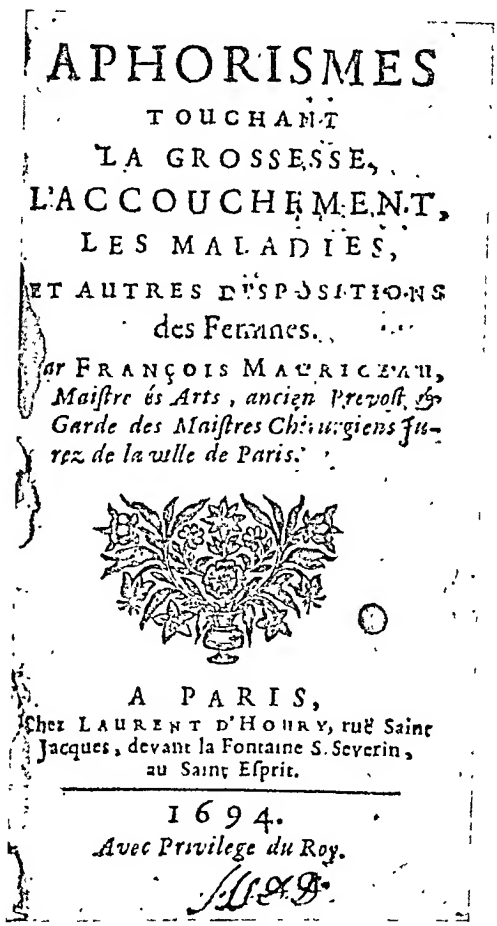
"The Midwife must from time to time taste (touch) the inward Orifice with her Finger, to know whether the Waters are ready to break, and whether the Birth will soon after follow: she must likewise anoint all the bearing place with emolient Oils, Hogs-grease, or fresh Butter, if she perceive that they can hardly be dilated, and all the while she must be near her Woman, to observe her Gestures diligently, her complaints and pains; for by this they guess pretty well, how the Labour advanceth, without being obliged to taste (touch) what comes from her Body so often."

"This Chapter might be very well spared, if every Practitioner had the Art the Translator professeth in his Epistle, of fetching a Child when it comes right, without Hooks or turning it."

In an interesting marginal note, Chamberlen comments upon Mauriceau's statement that it is important to know whether the child is alive or dead, and if dead, the procedure for delivery. Chamberlen says:

"This is not so necessary to those Practitioners which can fetch a Child coming right, or with the Arm, without Hooks or Sharp Instruments, as the Translator of this Book and his Father and Brother can."

Mauriceau published his aphorisms concerning pregnancy, delivery and diseases of women (Fig. 36) in Paris in 1694. This book was probably in-


APHORISMES
TOUCHANT
LA GROSSESSE,
L'ACCOUCHEMENT,
LES MALADIES,
ET AUTRES DISPOSITIONS
des Femmes.
Par FRANÇOIS MAURICEAU,
Maistre és Arts, ancien Prevost & Garde des Maistres Chirurgiens Jurez de la ville de Paris.

A PARIS,
Chez LAURENT D'HOURY, ruë Saint Jacques, devant la Fontaine S. Severin, au Saint Esprit.

1694.
Avec Privilege du Roy.

Fig. 36.—Title page of the *Aphorismes* by François Mauriceau, Paris, 1694.

tended for midwives and beginners in the study of obstetrics and contains in succinct form a recapitulation of most of the material contained in his larger treatise.

A worthy pupil of Mauriceau's was **Paul Portal** (1630–1703) (Fig. 37) who was born at Montpellier and who entered the Hôtel Dieu as a student about 1650, where he remained until 1663, attending Mauriceau's lectures and clinical practice. In 1659 he was assigned to deliver the "spoilt women" who applied at the Hôtel Dieu and was also chief of the surgeon-assistants

Portal followed Mauriceau in his method of practice, as Mauriceau had followed Guillemeau. His chief contribution to the science of midwifery lies in his clear recognition of placenta praevia; its anatomy and clinical importance.[1] Portal's description of the condition is found in his Observation No. LXIX, wherein he describes the case of a woman whom he delivered January 11, 1679. The patient had been bleeding for several days and on examination Portal found that the cervix was well dilated and that

"I could put in three of my fingers foremost; I seach'd with one finger first and found the after-burthen foremost, and closely joined round the inner orifice of the womb, which was the occasion of the excessive flux of blood; and as it had reduced the woman to a very low condition, so this join'd to the other circumstances, made me fear the life both of the woman and child."

After sending for a physician who prepared a prescription for the patient, Portal notes that the hemorrhage continued and it was resolved to

". . . . have her deliver'd, notwithstanding the great danger that must needs attend it . . . I found some means to convey my hand (well greased before) into the inner orifice of the womb, where I again felt the after-burthen fasten'd to it. . . . I peel'd it off by degrees, and brought it out; and then turning my hand again in the womb, the first thing I met with, was the navel-string, along which I guided my hand first to the child's belly, and then downwards to the thigh, and thence lower to the leg and foot. . . . Whilst I was pulling this foot the other follow'd, and the whole body after it."

Portal notes that the child was alive and that the woman, who had been practically moribund, shortly recovered consciousness. Subsequently, the patient pursued a slow convalescence with an intermittent fever. The only untoward result to this patient was that three weeks after delivery she lost the sight of one of her eyes through violent inflammation, the cause of which Portal does not understand.

The French writers on midwifery profoundly influenced English practice as has been noted in the case of Mauriceau. There are numerous indications in Smellie's work[2] of his great admiration for the practical procedures laid down by **Guillaume Mauquest de la Motte** (1655–1737). In fact, both Mauriceau and La Motte were regarded by Smellie as authorities who wrote out of the fulness of experience and with a minimum of fanciful theorizing.

La Motte's work, *A General Treatise of Midwifery: illustrated with upwards of Four Hundred Curious Observations and Reflexions Concerning that Art*,[3] is based very largely upon that of Mauriceau. He says in his preface that he regards his period as the "modern" period and that, as he looks back and studies the writings of Paré and Guillemeau, he cannot but be conscious of the perfection to which midwifery has been brought by the "care and application of the moderns." He claims that Mauriceau was the first to treat the subject "with order, clearness and erudition." At the outset he pays tribute to the great practical value of attendance at the Hôtel Dieu in Paris:

"It is certain, that this hospital is the best school in *Europe* for surgeons, and I should have been very glad to have been admitted to be present at *labours*, during the five years that I was employed in that house; but there being but one surgeon charged with that

[1] Fasbender, loc. cit.
[2] *A Treatise on the Theory and Practice of Midwifery.* London, 1779.
[3] Translated into English by Thomas Tompkyns. London, 1746.

He notes that Dr. Smellie compared the translation with the original to the end that "nothing useful might be left out, and nothing useless retained." The frankness and candor of La Motte's descriptions, their detail, the record of failures as well as successes, stamp his treatise as one of the most valuable contributions to the science of midwifery of the period. La Motte's treatise consists of five books. In one interesting case (Observation cccxxi), early in La Motte's practice, a large femoral hernia threatened to interfere with labor. La Motte fixed the woman with her head downward, the buttocks raised and in this position retained the hernia by gravity until labor had been completed.

"When she got up I persuaded her to wear a truss, which prevented its coming down, and made her life much easier."

La Motte's observations on this case are unique:

"A proper situation is certainly of great service in a difficult and lingering *labour*, but when the pains are brisk, and the child strong and vigorous, a woman would be brought to bed, tho' her head hung down, and her feet were up."

In another case (Observation ccxxiii) La Motte describes a slow labor in which he discovered that the bladder had not been emptied and that urine could not be passed voluntarily. He promptly introduced a catheter and this

". . . . was no sooner done, than the water gushed forth in such a quantity, that it is hardly credible how the bladder could distend so much without breaking. This gave her ease immediately, and she enjoyed her health to her *delivery*, having shown her how to ease herself."

Numerous cases of eclampsia are recited and although he makes no pretense of understanding the cause of the convulsions, La Motte advises delivery as promptly as possible, first emptying the rectum and the bladder.

The teaching of midwives as a regular academic procedure was inaugurated by **Jean Astruc**[1] (Fig. 38) (1684–1766) who in his *The Art of Midwifery Reduced to Principles*, etc.,[2] relates that in 1745 he was appointed by the Faculty of Medicine of Paris to give a course of lectures to the midwives and their pupils. This was a new departure in French medicine and the teaching of midwives in some responsible fashion inaugurated in that year has continued until the present day. This course aroused Astruc's interest in obstetrics, and, as he admits, compelled him to study the subject with great

[1] Jean Astruc, "Professeur Royal du Médecine, et Médecin Consultant du Roi," was born at Sauve, in Languedoc. He studied medicine at Montpellier, where he "sacrificed to the pleasure of study and observation all the amusements of his age and even the pardonable delights of Society." In 1703 received his M. D. degree. In 1710 he won by competition the chair of anatomy and medicine at Toulouse. In 1717 he was a member of the faculty at Montpellier. The King of Poland called him to be his physician in 1729, but the following year Astruc went to Paris where libraries were accessible for the prosecution of his studies. Almost immediately he was honored with the title of Consulting Physician to the King, and in 1731 was appointed to a chair in medicine in the Royal College. His lectures were marked by such grace of style that many people who had no interest in medicine attended them to hear "models of beautiful Latinity." The Faculty of Medicine honored him in 1743 by coöpting him unanimously as one of its members. He took an active share in the researches of a commission appointed by the Faculty to report on inoculation. (From article by Alexander Simpson in *Proc. Roy. Soc. Med.*, 1915, vol. viii, pt. 2.)

[2] London, 1767.

"This remedy consists, as may be well conjectured, in quickly delivering the woman, although she may not be at her time. By this means the *uterus*, being freed from the child, contracts itself; the veinous *appendices* grow less and narrow; the blood flows more sparingly, and, after some time, ceases to be discharged at all, and the patient is cured."

As has been noted earlier, both Guillemeau and Madame Bourgeois advocated this procedure and Guillemeau's case histories are definite and convincing.

Astruc decries the numerous horrible looking instruments that are depicted, for example, in Paré. In his paragraph on forceps, he makes no mention of Chamberlen, but suggests that all obstetricians secure Levret's book where the description of the forceps and its use will be found. He says:

Fig. 39.—Jean René Sigault. From *Accoucheurs et sages-femmes célèbres* by G. J. Witkowski.

"This is the last step to perfection of the art of midwifery; and it was the more momentous, as it banished the use of crotchets, always terrifying, and often fatal to the patient."

The last quarter of the eighteenth century witnessed the proposal of an operative procedure—pertaining to midwifery—that aroused the greatest interest and initiated a prolonged controversy. For a time it was one of the principal topics under discussion in obstetrical circles throughout Europe. The history of the procedure may be stated briefly. Toward the latter end of the year, 1768, **Jean René Sigault** (Fig. 39) presented a communication to the Royal Academy of Surgery of France, recommending the division of the symphysis pubis as a substitute for cesarean section. He stated that he had performed the operation several times on cadavers and that he could easily gain an inch as a result of the division of the symphysis. He admitted that the opinion of those with whom he had discussed the procedure had not

It is worthy of note that this widespread enthusiasm followed the report of but a single case.

Under date of May 5, 1778, Alphonse le Roy wrote to John Leake, teacher of midwifery in London, and enclosed a copy of his report on division of the symphysis pubis. Sigault's name is not mentioned. Le Roy says:

> "I entreat your acceptance of my publication on the *new operation* of cutting the *symphysis pubis*, which I have successfully performed. I likewise inclose a report of the Medical Faculty of *Paris*, and a *Thesis*, which has lately been discussed in our College, wherein my principles are adopted; together with *six examples* of the success of this operation. *I give Lectures in Midwifery, etc.*, and am the first in our faculty who has so devoted himself to this branch of physic, which in France belongs to surgery. I am acquainted with your *Practical Observations, etc. on the Child-bed Fever.* I adopt your principles, and take pleasure in praising your talents. I have given a History of the Principal *Accoucheurs*, wherein *Smellie* and you, Sir, hold a distinguished rank."

OBSERVATIONS

SUR

LES CAUSES ET LES ACCIDENS

DE PLUSIEURS

ACCOUCHEMENS

LABORIEUX,

AVEC DES REMARQUES

Sur ce qui a été proposé ou mis en uſage pour les terminer; & de nouveaux moyens pour y parvenir plus aiſément.

Par M. A. LEVRET, du Collége & de l'Académie Royale de Chirurgie, Accoucheur de Madame la Dauphine, &c.

Troiſiéme Edition, revûe & corrigée.

A PARIS,

Chez P. ALEX. LE PRIEUR, Imprimeur du Collége & de l'Académie Royale de Chirurgie, rue Saint Jacques à l'Olivier.

M. DCC LXII

Avec Approbation & Privilége du Roi.

Fig. 40.—Facsimile of the title page of the third edition of *Observations sur les causes et les accidens de plusieurs accouchemens laborieux* by André Levret, Paris, 1762.

In this era the failure of the operation was to be expected and the much heralded new and safe substitute for cesarean section was all but forgotten until with antisepsis and asepsis it was revived by the Italian, Spinelli, a pupil of Morisani. It should be noted that in spite of a high mortality, Italian obstetricians had retained the procedure as of value in certain cases.

The outstanding figure in eighteenth century French midwifery was André Levret (1703–1780).[1] His logical deductions relative to the mechanism

[1] Further mention of Levret and his work will be found in the chapter on Forceps.

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DISEASES OF THE CARDIOVASCULAR SYSTEM

With childbearing must come certain circulatory readjustments on the part of the mother. A few of these circumstances are apparent. For example the physical load of the growing uterus with its fetal content constitutes an added burden to the circulation. The increased metabolism increases the demand for oxygen and eventually the circulatory load. The increased intra-abdominal pressure tends to widen the costal arch and at the same time the diaphragm is forced cephalad. Both factors impair the respiratory efficiency and reduce the respiratory aid to the circulation. Since the diaphragm normally exerts the more potent force in aspirating blood into the thorax, impairment of its free piston movement during pregnancy is the more serious factor. Furthermore the elevation of the diaphragm distorts the position of the heart. As the apex is swung up and out the heart comes to occupy a characteristic transverse position in the thorax. The hypertrophy of the uterine wall with its large venous sinuses and the free placental circulation impose a further necessity for readjustment upon the circulation.

Somewhat less apparent, but none the less important, are certain changes in the blood volume. Neubauer,[1] and Rowntree and Brown[2] determined a definite increase in the blood volume in pregnancy. The latter workers termed this increase a simple hypervolemia, since the total change is represented by the increased plasma volume. Neubauer[1] noted a slight fall in blood volume just before delivery and a further sharp reduction to a subnormal level postpartum. Gammeltoft[3] and Stander, Duncan and Sisson[4] reported increased minute volume output of the heart in pregnancy. In dogs, Stander and his co-workers[4] determined a fall in the minute volume after labor, by the gaseous exchange method of Marshall, which reached normal in two to three weeks. The increased blood volume plus the increased

minute output of the heart unquestionably call upon the cardiac reserve. Whether hypertrophy occurs is still a mooted question. Mackenzie[5] and other observers have not subscribed to the so-called "physiologic cardiac hypertrophy" of pregnancy. The transverse position of the heart and the weight changes of the subject introduce two variables which vitiate even the more accurate methods of teleroentgenology and orthodiagraphy.

Interesting observations have been made upon the peripheral circulation in pregnancy. Faught[6] found no increase in the arterial blood pressure in normal pregnant women. Hare[7] carried this observation further to prove that not only did the blood pressure remain at a low normal level throughout normal pregnancy, but also that exercise tests were adequately responded to over the same period. Stieglitz[8] reported an inverse relationship between the calcium content of the blood and the arterial blood pressure. With a moderate hypocalcemia in the last month of pregnancy there appeared a gradual rise of blood pressure which fell immediately postpartum with the rise of blood calcium. Somewhat later, with the institution of lactation, the blood calcium fell and there occurred a coincident rise of blood pressure. Capillary pressure readings were not found to parallel arterial blood pressure changes by Nevermann,[9] nor was he able to determine any significant capillary pressure alterations in pregnancy, labor or the puerperium. As might be anticipated, Runge[10] found markedly elevated venous pressure readings in the lower extremities during pregnancy with a fall in the puerperium. These changes must be borne in mind in explanation of the varicosities and thromboses so common in these vessels.

Labor, in the majority of instances, evidences the greatest burden upon the circulation. Fellner[11] observed the rise of blood pressure with the pains of labor and the trend of the same through labor and the puerperium. He noted the fall of the pulse rate, sometimes to an actual bradycardia, after labor. In his judgment the third stage of labor is the most dangerous from a circulatory standpoint. The serious burden of labor upon an unstable or uncertain myocardium can best be appreciated by duplicating the physical strain in the so-called "Valsalva experiment." Herein the chest is in an inspiratory position and a forced expiratory effort is made with the glottis closed. Dawson and Hodges[12] have followed the arterial blood pressure under the conditions of the experiment and have found a sharp rise up to a given point, then a marked fall (with a later inconstant rise). Similar blood pressure changes were noted during labor pains in the anesthetized and tracheotomized rabbit. The subject's pulse rate at first was elevated and then tended to fall with an ultimate late rise. Under the same conditions (Valsalva) Meyer and Middleton[13] found a sharp and pronounced rise in the venous pressure which was maintained as long as the expiratory effort was continued. Such observations furnish concrete clues to clinical experience in cardiac failure during labor.

Mackenzie,[5] whose monograph on "Heart Disease and Pregnancy" has done more to clarify the subject than any other single contribution, cautioned against the heedless practice of branding all individuals with murmurs as cardiac cripples. Heaney[14] likewise stressed this point. Newell,[15] in one of the most masterly articles available upon the subject, emphasized the fact that approximately 10 per cent of all women develop murmurs during pregnancy. Many more have symptoms referable to the heart in pregnancy,

most of which disappear after rest. Breed and White[16] pointed out that dyspnea, fatigue and palpitation may depend upon the effort syndrome rather than a myocardial incompetency complicating pregnancy. Mackenzie[5] has likewise shown that cardiac neuroses may simulate organic disease of the heart. He furthermore noted that extrasystolic arrhythmia occurred in 50 per cent of normal pregnant women without evidence of circulatory inadequacy. The successful conclusion of every case in a considerable series at term led Mackenzie to conclude that the appearance of extrasystoles unaccompanied by other signs is of little consequence in pregnant women.

Chronic Organic Disease of the Heart.—Under this heading it is proposed to include all chronic affections of the heart of whatever etiologic origin. In the age period represented by childbearing women congenital lesions will form a very small group. Then, too, the degenerative changes of arteriosclerosis, so important later in life, will not have made their influence felt at this period. Of the large infectious group, syphilis as an etiologic agent plays a part second to rheumatic fever. The age period includes the earlier incidence of syphilitic aortitis; but, by and large, the rheumatic series constitutes the greatest circulatory problem in pregnancy. In this group are included rheumatic fever, chorea, recurrent tonsillitis, and erythema nodosum.

Valvular defects, septal deficiency and abnormal communications between major vascular trunks constitute the chief cardiac threats of congenital origin. Syphilis involves the suprasigmoid portion of the arch of the aorta primarily, and from this strategic location it imperils the elasticity of the aorta, the nutrition of the myocardium and the integrity of the aortic valves. Myocardial degeneration results from encroachment upon the coronary orifices or from intercurrent atherosclerosis of these nutrient vessels in the majority of cases; less often from direct syphilitic involvement of the myocardium. With aortic valvular involvement by the syphilitic process, hypertrophy and dilatation of the left ventricle ensue to meet the load of the regurgitant stream. In the case of the rheumatic affections any or all of the histologic units of the heart may be involved. Although clinically, and even pathologically, endocardial or pericardial involvement may dominate the picture, from recent studies it is doubtful whether the myocardium ever escapes. Lesions of the serous covering or lining of the heart may eventually impose physical burdens upon the myocardium; but, independently, pericardial and endocardial changes do not lead to circulatory embarrassment. Admittedly, the circulatory efficiency is determined by the degree of myocardial integrity and only with an impairment of its contractile power will symptoms and signs of circulatory incompetence arise. Such a viewpoint modifies the judgment of the significance of the several valvular lesions. In the last analysis the clinician must interest himself in the capability of the myocardium to maintain an adequate circulation in the face of ordinary or extraordinary requirements.

Mackenzie[5] noted that breathlessness and cardiac consciousness in oppression or pain constitute the earliest evidences of circulatory inadequacy, and are reflections of an impairment in the quality or a deficiency in the quantity of the blood supply. Early fatigue and palpitation have likewise been remarked in this connection. Obviously, under conditions of increased effort even the most robust circulation may at a given point show signs of flagging; hence Mackenzie[5] reasoned that normally the heart has a rest

force and a reserve force. The rest force of the heart is adequate for all circulatory demands of the body in repose, while the reserve force is called upon only during effort. Naturally the reserve force will be a variable quantity within wide ranges in normal individuals, while in disease particularly affecting the myocardium, this factor will be seriously encroached upon and limited. Indeed, in severe grades of myocardial incompetency the rest force of the heart may likewise be invaded and the patient experience dyspnea and cardiac consciousness at rest. Cyanosis, pulmonary edema, hepatic engorgement, anasarca and all the other evidences of cardiac failure are merely advanced steps in the same process.

Many other efforts have been made to effect a clinical division of cardiac patients in pregnancy, with the thought of improving the accuracy of prognosis. Functional grouping has appeared more logical than anatomical. Among these Pardee's[17] arrangement has been especially helpful. He has attempted a division of the patients with organic heart disease according to their response to effort:

Class I. Ordinary exercise without fatigue, palpitation, or dyspnea.

Class IIA. Discomfort experienced on ordinary exercise.

Class IIB. More difficult exercise completed without discontinuance on account of symptoms.

Class III. Simplest effort leading to fatigue, dyspnea, or palpitation.

Obviously such terms might be reduced to grades of encroachment upon the reserve and rest force of a given heart.

Among the valvular lesions mitral stenosis and aortic regurgitation hold the highest places for gravity in pregnancy. Mitral stenosis imposes a heavy burden upon the left auricle, the pulmonary circuit and the right ventricle. With the further burden placed upon respiration by the pregnant uterus, there is an added risk of failure at this time. Then, too, since the myocardial involvement is an inevitable concomitant, the respect in which this lesion has been held seems well warranted in pregnancy. Mackenzie[5] maintained that if the subject shows only a presystolic murmur and a good response to effort, and if there is no pulmonary edema, pregnancy is not contraindicated. Irritability of the myocardium, cardiac enlargement and poor exercise response were cited as contraindications to pregnancy in mitral stenosis. Hunt and Campbell[18] covered the ground thus:

"1. Provided the heart is not enlarged patients with mitral disease stand pregnancy well and there is not much extra risk.

"2. If the heart is enlarged, the risk is increased, and it does not make much difference whether the valvular lesion is aortic regurgitation or mitral stenosis. The amount of extra risk depends upon the degree of enlargement and the treatment which can be adopted during pregnancy.

"3. In auricular fibrillation the results are so disastrous that pregnancy should be prohibited."

Corwin and her fellow workers[19] gave aortic regurgitation first place in the category of serious heart lesions in pregnancy. Newell[15] ranked mitral stenosis above aortic regurgitation. Mackenzie's[5] experience in the complication of aortic regurgitation was limited to 2 cases, neither of which regained lost ground postpartum. He felt that gross cardiac enlargement, water-hammer pulse and a distinct limitation of the response to effort, were contraindications to pregnancy.

The rhythm of the heart plays an important part. As previously remarked, Mackenzie[5] attributed no significance to extrasystolic arrhythmia. Paroxysmal tachycardia has been reported as a complication of pregnancy by Meyer, Lackner and Schochet.[20] Their report called attention to the importance of its differentiation from concealed hemorrhage, shock and massive collapse of the lung. The past history of similar attacks is important in this relation. Auricular fibrillation occupies the undisputed position of the most serious disturbance of rhythm observed in pregnancy. Corwin et al.[19] are almost alone in their position of conservatism in this regard. True, the pregnancy may be carried to term successfully, but few physicians would sanction conception were knowledge of such a disturbed rhythm available. An antecedent rheumatic history and the presence of mitral stenosis are the rule. Electrocardiographic studies have led Herrmann and King[21] to give especially serious prognostic significance to incontrollable auricular fibrillation and bundle branch block. The former proves particularly dangerous as a complication of hyperthyroidism in pregnancy.

The prognosis of chronic organic disease of the heart complicating pregnancy raises many interesting points. From a medical standpoint one of the most interesting observations of recent years has been the successful attempt to such workers as Mackenzie[5] and Pardee[17] to anticipate the outcome of a given case on the basis of the evident limitation of the cardiac reserve. Important in this relation is a close inquiry into the details of circulatory response to effort over a considerable period of time, with further questioning, in event of previous pregnancies, as to possible adverse manifestations. Daly[22] felt that a majority of patients, even those showing cardiac failure, can be carried through to term without material damage to the heart from the pregnancy, provided proper treatment be instituted early. Breed and White[16] lost 4 per cent of 53 cases of heart disease complicating pregnancy. Both of the fatal cases suffered from mitral stenosis; one was complicated by an acute endocarditis and the other had auricular fibrillation. Their group included 36 patients with mitral stenosis. French and Hicks[23] found a distinct relationship between pregnancy and the development of signs of decompensation in 57 married women with mitral stenosis (28 per cent of total group as compared with Fellner's[11] 6.3 per cent). One of these[23] did not develop signs of circulatory failure until the thirteenth pregnancy. (Neuhof[24] reported the incidence of 18 pregnancies in a woman with mitral stenosis.) Where information was available in French and Hicks' series (50 patients), 25 had developed signs during pregnancy and 25 in the puerperium. Abortion occurred in 5.5 per cent of 36 subjects coming into the hospital pregnant. Fellner's[11] figure of 20.2 per cent abortions far exceeds this; this observer placed the infant mortality at 25.5 per cent. In severe decompensation the survival of the child must be despaired of because of the anoxemic placental circulation.[21] French and Hicks[23] concluded, "We do not deny pregnancy may cause serious, and even fatal, cardiac failure in cases of mitral stenosis. We think, however, that the dangers of pregnancy in these cases have been overstated." Their mortality figures were 13.9 per cent in three months. Fitz Gibbon[25] gave a more serious prognosis from a small series of 22 subjects of whom 5 died. He stressed the improved prognosis with the recognition and treatment of decompensation early in pregnancy. Where neglected until labor, the outlook was invariably bad. He pointed out,

further, the tendency to prematurity in multiparae with decompensation. Mackenzie[5] carried a patient with a patent ductus arteriosus through two successful pregnancies. Some idea of the seriousness of auricular fibrillation may be gathered from Robinson's report[26] of the death of 13 of 18 women with this type of arrhythmia during or shortly after delivery. He pointed out that labor in the presence of cardiac failure is either immediately fatal or hastens the end. In spite of the weight of evidence for an earlier termination of life in rheumatic heart disease as a result of pregnancy, some workers, as Reid,[27] believe that the natural evolution of the disease rather than childbearing is responsible.

Physicians today are alive to their responsibility in the protection of cardiac cripples. The management of the chronic organic cardiac patient begins with an assessment of her ability to withstand the stress of pregnancy. The criteria for this judgment have been elucidated. If conception occurs against or without the advice of the physician in a woman who shows manifest signs of circulatory inefficiency, she should be placed in bed at once on a proper regimen to support the myocardium at the same time that all undue strain is removed. Daly[22] and others have indicated that abortion under such circumstances imposes a further insult upon the myocardium and may be disastrous. As Newell[15] remarked, the physician is interested in three ends, namely, a living mother, reduction of the injury to the damaged myocardium to a minimum and a living child. If pulmonary edema persist and the reserve be further exhausted, abortion is justifiable in the early months of pregnancy and sterilization advisable. No physician is warranted in condemning a woman to invalidism or death when every sign spells disaster. Circulatory failure developing later in pregnancy encourages the prospect of a viable child. Every measure should be taken to protect the mother against strain during the remaining months and then delivery accomplished with a minimum of effort to the patient. Particular pains should be taken to shorten the second period of labor or by the more generally accepted plan to deliver by a cesarean section prior to labor. Spinal anesthesia has removed one of the serious objections to this procedure; and it offers the possibility of sterilization at the same time if it be deemed advisable.

The medical treatment of the decompensation occurring in pregnancy differs in no detail from that applied under any other circumstance. The serious congestive failure with extreme cyanosis, orthopnea, venous engorgement, pulmonary edema, hepatic enlargement and elevated venous pressure frequently responds well to venesection. Not less than 500 cc. of blood should be let. Morphine in full therapeutic doses may be beneficial. Oxygen inhalations afford remarkable relief at times. The sheet anchor in therapy is digitalis. The preparation of choice is the tincture. Given in doses proportional to the body weight, tolerance should be sought in not less than four or five days. The tolerance dose averages 0.15 cc. per pound of body weight and in the calculation of a theoretical tolerance dose, 1.5 cc. is estimated to be lost each day. Hence if a patient weighs 100 pounds, she will need 15 cc. of the tincture of digitalis for theoretical tolerance. If then in a moderate case of decompensation five days are elected as the period in which tolerance dosage is to be sought, 3 cc. will be given daily plus the 1.5 cc. lost or a total of 4.5 cc. of the tincture. However, this mathematical formula cannot be maintained rigidly in a biological problem. Digitalis, like any

other drug, is given for its therapeutic effect, which may be judged in three details: Slowing of the pulse, improvement in evidences of decompensation and diuresis. When such signs are forthcoming, the dosage may be reduced to a maintenance level of 1.5 cc. a day. Not infrequently the manifestations of digitalis intoxication precede the therapeutic effects. Anorexia, nausea and vomiting usually anticipate the more serious conduction alterations and constitute warnings for the readjustment of dosage. A salt-poor diet, low in fluids (1500 cc. daily), is useful in the water-logged patients. The xanthine diuretics, theobromine sodiosalicylate and theophylline in doses of 0.6 Gm. three times a day for interrupted periods of three days each may be helpful. Occasionally the mercurial diuretics, novasurol and salyrgan, 0.5 to 2 cc. intravenously on alternate days for four doses, with or without ammonium chloride by mouth, may induce marked diuresis where all other measures have failed. The aspiration of the serous cavities and scarification of the extremities may be resorted to in intractable cases.

Acute and subacute endocarditis are infectious diseases and may occur in the course of pregnancy as well as at any other time. Since subacute bacterial endocarditis is nearly always implanted upon a valve previously the seat of rheumatic involvement, the wonder grows that it is apparently so rare a complication of pregnancy. The characteristic clinical course of both of these conditions and the tendency to embolic showers or lodgment in vital structures should rule out any great tendency to diagnostic error. Then, too, the mortality is so high that the clinically overlooked cases should in a certain proportion be revealed at necropsy.

Weichselbaum[23] reported a case of pneumococcic endocarditis in which spontaneous abortion occurred in the sixth month of pregnancy and death followed six weeks later. Harris and Dabney[29] found the gonococcus to be the cause of a case of endocarditis dying in the puerperium. Findley[30] found the Streptococcus viridans in a patient, sixteen weeks pregnant, who suffered from chills, fever, dyspnea and palpitation. There was aortic and mitral involvement. The joints were very sensitive and uremia terminated the picture after the interruption of pregnancy had failed to relieve the evidences of renal insufficiency. Walser[31] added 2 further cases in 1928. His contribution was especially valuable in that it pointed out the inadvisability of therapeutic abortion. The disease is almost invariably fatal and the continuance of pregnancy has no apparent influence upon the mother. Transplacental transmission of the infection may be anticipated in a certain percentage of cases; but there is a remote chance for a viable child. In the first of his cases, a normal child was delivered and no evidence of sepsis developed, although Streptococci viridans were isolated from the umbilical cord. The mother died one month later. The second child was delivered five weeks before term and died the succeeding day. Cultures from the spleen showed no growth, but the heart's blood showed nonhemolytic streptococci. Multiple infarcts of the brain with internal hydrocephalus were determined at necropsy. This mother died several months later.

Varicosities, Thrombosis and Embolism.—Runge[10] remarked a rise in the venous pressure in the legs and to this factor attributed the tendency toward varicose veins during the childbearing period. The position of the gravid uterus with reference to the venous return from the pelvis and the lower extremities is the key to this situation. The varices in the vulva

may constitute a serious problem in the conduct of labor, since their rupture may induce grave hemorrhage.

The pathologic background of thrombosis is a combination of several factors, namely, alteration in the blood, the blood stream or the vessel wall. This complication is rare during pregnancy but is comparatively common in the puerperium (see Chapter XXXIX). Runge[10] reasoned that the postpartum fall in the venous pressure is an important factor in the formation of a clot *in situ* in the veins of the leg. Goldsborough[32] cited an instance of thrombosis of the internal iliac vein during pregnancy which he attributed to tight lacing in an attempt to conceal the pregnancy. In this instance there was no bacteriological evidence of infection. Deucher[33] forcibly impressed the necessity for gymnastics in the prevention of thrombosis in the pregnant woman and the even greater need of absolute quiet and the avoidance of local manipulation after the development of thrombosis.

Pulmonary embolism stands high among the causes of sudden death in pregnancy, labor and the puerperium. Sperling[34] collected 33 reported cases from the literature up to 1893. Of this group 26 proved fatal. Zweifel[35] determined pulmonary embolism to be the cause of death in 5 of 11 sudden fatalities in pregnancy and the puerperium. Bunzel[36] found an incidence of 0.1 per cent of pulmonary embolism in 716 pregnancies in a group of maternity hospitals in New York City. Of importance was its occurrence three times more frequently in operative than in normal deliveries. One and one-half per cent of all patients undergoing cesarean section and 2 per cent of placenta praevia patients experienced this complication. In a group of 24 patients delivered, the onset was immediate in 6; in twenty-four hours, 2; third to the ninth day in 7; ninth to the twentieth day in a like number, and after the twentieth day in 2. The mortality in this group of 24 patients was 66.6 per cent. Seventy per cent of the fatal cases died within an hour of the accident and 90 per cent within twenty-four hours. Emboli are derived in a majority of instances in pregnancy, labor or the puerperium from thrombi in pelvic or peripheral veins; but other sources such as mural thrombi in fibrillating auricles or beneath devitalized areas of the myocardium and friable valvular vegetations may result in remote embolism.

The manifestations of pulmonary embolism of sufficient degree to lead to infarction are very impressive. The patient is stricken with an excruciating pain in the involved side. The respirations become shallow and labored. The facial expression is anxious. Pallor is the rule, but it may give way to cyanosis. The skin is leaky. The pulse is thin and thready. The blood pressure is markedly depressed, completing the objective manifestations of shock. A cough almost invariably adds to the discomfort and within a few hours is productive of considerable quantities of blood, which at first is bright red and fluid but eventually becomes very dark and clotted. Of the physical signs a pleural friction over the localized site of persistent congestive râles and suppressed breath sounds is probably the most helpful. Later the signs of consolidation may prevail or fluid may form in the pleural cavity to mask the underlying pulmonary changes. Jaundice is noted within eighteen to twenty-four hours after practically all pulmonary infarctions of notable degree. Whether septic or not, embolism of the lung is attended by a febrile reaction in the majority of instances. In the event of a septic embolism, abscess of the lung is almost inevitable.

As previously indicated, the treatment of pulmonary embolism is primarily prophylactic; a certain percentage of instances, arising from thrombosis of the peripheral veins, may be avoided by meticulous care in the handling of these parts. Desperate as the prognosis of pulmonary embolism is, much may be done for the comfort of the patient. Supportive measures are indicated; but more particularly attention should be drawn to the marked relief afforded by the judicious use of morphine and oxygen.

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DISEASES OF THE DIGESTIVE SYSTEM

Liver and Bile Passages

Icterus.—Appreciation of the hepatic factor in the toxemias of pregnancy has led to a closer study of icterus gravidarum. Full discussion of this subject is given in Chapter XXX. Excluding those cases which go on to a frank toxemia and those in which an obstructive factor such as cholelithiasis is responsible for the jaundice, there remains a group of patients in whom jaundice is a conspicuous symptom. Wendt[1] treated of this subject exhaustively before the relationship of hepatic injury to the toxemias of pregnancy was well understood. Von den Velden[2] divided these cases into two groups, namely, accidental icterus and the icterus of pregnancy. He attributed the latter to a toxic cause, rather than a mechanical one.

Particular significance attaches to the entire question in the light of the French contributions. Brulé[3] has proved that there is a definite hepatitis with degenerative changes even in the milder cases of so-called "catarrhal cholangitis." Hence the latter condition must always be viewed with misgiving, particularly when observed in the course of pregnancy.

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Gallstones.—The occurrence among women of 70 to 80 per cent of the cases of cholelithiasis recorded in the literature naturally raises the question of the possible relation of the reproductive function to this disease. The problem becomes even more pertinent by reason of the marked preponderance of the incidence of gallstones in women who have at some time been pregnant.[1] The alteration in the blood cholesterol during pregnancy has long been recognized. Fluhman[2] reviewed the literature (1926) and concluded that the increase in cholesterol is determined by an increased production and decreased excretion. Lactation was deemed responsible for this altered status, since it could in no way be attributed to the fetal needs. There is apparently no

sistency in describing recommended procedures. There is scarcely one, he says, whom we do not often find contradicting his own principles. He notes that the processes of delivery are purely mechanical procedures "subject to the laws of motion" and he quotes Astruc in support of this point of view. He believes that the entire practice of midwifery up to the time of Mauriceau could be summed up in the statement that whenever the child presented properly, nature effected the delivery; whenever the child presented in an abnormal manner the office of the obstetrician was to dismember the child and empty the uterus. He praises Paré for at least awakening the curiosity of the French surgeons, who thus intrigued began to study the subject of midwifery and aided greatly in bringing it to its present state of perfection. Mauriceau is regarded by Baudelocque as the first real accoucheur and he names as the followers of Mauriceau, Cosme Viardel (c. 1671), Phillipe Peu (d. 1707), Portal, Deventer, Pierre Amand (d. 1720), La Motte and lastly Smellie and Levret.

> "With them (Smellie and Levret) began the most brilliant epoch of the art of midwifery. The forceps, recently invented, but scarcely yet perfectly sketched, having received a new form from the hands of those two celebrated men, but especially from those of *Levret*, entirely changed, as I may say, the face of the art, by causing crotchets and other instruments of that kind to be laid aside, which we were often under the melancholy necessity of employing, to extract from the womb of the mother the unfortunate child, who could not be spared but by sacrificing her. Though such instruments are still in use, a skilful man never employs them but when there remains no doubt of the child's death."

To Chapman, Baudelocque gives great credit for the publication of his illustration of the forceps. He says the forceps were not well known until 1734 or 1735 when Chapman communicated them to the public. In discussing the relative position in the history of midwifery of numerous contributors, he indicates that Mauriceau, Smellie and Levret stand quite apart from the great group of writers, each of whom has contributed something, but little in comparison with the three first named.

Baudelocque devotes several pages of his introduction to a tribute to his friend, François Louis Joseph Solayrès de Renhac, whose premature death cut short what Baudelocque believes to have been the most promising career in French midwifery. Solayrès was born in 1737 at Calhac. He studied at Montpellier, graduating in medicine in 1765. In the same year he became a member of the Royal Society of Science and for a time taught anatomy and surgery in association with the medical faculty of his Alma Mater. About 1770 he removed to Paris and was elected to membership in the Collège de Chirurgie, submitting his admission thesis under the title, *Dissertatio de Partu Viribus Maternis Absoluto* (Fig. 42). Baudelocque says:

> "This thesis is a complete treatise on natural labour, the mechanism of which had never till then been perfectly developed."

Eduard Caspar Jacob von Siebold (1801–1861) republished Solayrès' thesis in 1831 with a full recognition of its epoch-making character. He states that Solayrès was the first writer to describe clearly the physiologic factors involved and the relation of the mechanical forces.

Baudelocque illustrates Solayrès' intimate knowledge of the mechanism of labor by quoting the case report of a patient who was undelivered at the

5. Barcroft, J., and Stevens, J. G.: The Effect of Pregnancy and Menstruation on the Size of the Spleen, Jour. Physiol., 1928, 66, 32.
6. Williams, J. W.: Obstetrics, New York, 6th ed., 1930, p. 591.

MISCELLANEOUS CONSIDERATIONS

Surgery in Pregnancy.—Conservation of life must dictate every decision for surgery in the face of pregnancy. Accordingly, operations of election are deferred as a rule until after delivery. However, the improvements in technic and in anesthesia have removed most of the risk of operation other than those upon the generative tract. Greenhill[1] found that even in the generative tract there is little risk of inducing abortion if the procedure does not extend within the cervix. He pointed out that the earlier the operations upon the internal generative apparatus, the greater the likelihood of interruption. This viewpoint should distinctly modify the time of surgical interference in such conditions as may eventually complicate delivery. Mussey and Crane[2] subscribed to the policy of surgical conservatism; but they noted that such major procedures as gastrectomy, splenectomy, nephrectomy and resection of the rectum had been performed without undue risk to the mother or the fetus. Rosser[3] noted that hemorrhoids may be treated surgically without danger of abortion.

In operations of necessity the maternal need takes precedence. When immediate surgery is unavoidable, the operation should be performed as expeditiously as possible and with a minimum of manipulation of the pelvic viscera. Surprisingly grave operations are survived and the incidence of abortion is quite low. Occasionally, the decision as to the induction of abortion to afford access to a deep-seated pathologic condition may confront the surgeon. Conceivably, as stated by Fairbairn,[4] the gravid uterus may obscure the segment of bowel which is the seat of a carcinoma leading to obstruction, and under such conditions evacuation of the uterus may become necessary. If in such a case there is a prospect for survival of the mother on resection of the bowel, the sacrifice of the fetus is justifiable; but if the prognosis is uncertain, operation should be deferred or a colostomy alone should be done until the child is viable. Then delivery by a cesarean section will afford an opportunity for exploration and possible resection of the neoplasm.

Bibliography.—1. Greenhill, J. P.: Operations During Pregnancy, Surg. Clin. N. Amer., 1927, 7, 669.
2. Mussey, R. D., and Crane, J. F.: Operations of Necessity During Pregnancy, Arch. Surg., 1927, 15, 729.
3. Rosser, C.: Hemorrhoids in Pregnancy, Amer. Jour. Surg., 1925, 39, 63.
4. Fairbairn, J. S.: Acute Abdominal Emergencies Complicating Pregnancy and the Puerperium, Brit. Med. Jour., 1927, 1, 456.

Hernia.—The increased intra-abdominal pressure of pregnancy exerts a long-continued strain upon the supporting musculature. The loss of tone attendant upon repeated pregnancies is common in multiparae. With the stretching of the abdominal recti and the ultimate loss of tone diastasis is not an uncommon result. Furthermore, there is in a certain proportion of patients a definite tendency for the accentuation of preexistent parietal defects. A sharp differentiation should be drawn between these conditions;

from a clinical standpoint eventration constitutes a distinctly separate problem from herniation.

The pregnant uterus may at times find its way into a hernial sac and constitute a serious problem in management. Adams[1] reviewed the literature in 1889. His studies revealed 24 cases of this type, which he divided into five groups depending upon the basic herniae, inguinal, crural, sacrosciatic, umbilical and ventral. There were 10 of the inguinal variety, 8 ventral, 4 umbilical, 1 crural and 1 sacrosciatic. The inguinal type of hysterocele apparently was the most serious since 4 of the 9 mothers for whom results were recorded, died. On the other hand, in the ventral series there was no maternal death among the 6 with reported results, but 2 infants succumbed. All mothers and offspring in the group of umbilical hysteroceles survived. The one mother with the crural hernia died, but the child was saved. One of Adams' group of collected cases of umbilical hernia was unusual in the passage of the uterus into the hernial sac during labor when the patient remarked an inability to bear down any longer. After forceps delivery and the extraction of the placenta the uterus was readily replaced into the abdominal cavity. Eisenhart[2] reported a remarkable case of inguinal herniation of the gravid right cornu of the uterus.

The physician would be remiss in the discharge of his duties who did not insist upon hernial repair in any woman confronted with the possibility of childbearing. Notwithstanding this charge, herniae ordinarily give the clinician little occasion for concern in the course of pregnancy. A majority of such patients escape trouble; but the wearing of a truss and the avoidance of strain should be advised as precautionary measures. If there is any suspicion of adhesions in the hernial sac or a past history of incarceration, an early repair may avert later difficulties arising with enlargement of the gravid uterus. Labor under such conditions introduces further difficulties which are materially lessened as the second stage of labor is shortened. In patients with marked diastasis or with actual umbilical or ventral herniae, forceps delivery is almost inevitable; whereas in hysterocele of the inguinal and crural variety, cesarean section is recommended.[1]

Bibliography.—1. Adams, S. C.: Hernia of the Pregnant Uterus, Amer. Jour. Obst., 1889, 22, 225.
2. Eisenhart, H.: Fall von Hernia inguinalis cornu dextri uteri gravidi, Arch. f. Gynaek., 1885, 26, 439.

Subphrenic Abscess occurring as a complication of pregnancy is a rarity just in so far as the conditions which underlie its development are unusual in these circumstances. Binney[1] reported a patient in whom a miscarriage succeeded an attack of appendicitis. At the time of operation a retrocecal gangrenous appendix and a subphrenic abscess were discovered. There appeared some transdiaphragmatic inflammation but no pus developed in the pleura.

Bibliography.—1. Binney, H.: Subphrenic Abscess Following Appendix Abscess During Pregnancy, Boston Med. and Surg. Jour., 1927, 196, 773.

Accidents.—**Burns.**—Asherson[1] cited a case in which a woman in the early months of pregnancy received extensive deep burns to the entire surface of

both lower extremities excepting the soles of the feet and the sites of the garters in a motorcycle accident. A compound fracture of the left leg was sustained at the same time. Bilateral amputation of the legs was necessary on the fifth day. Secondary hemorrhage and a slight osteomyelitis of the stump complicated the immediate convalescence. Facial erysipelas appeared one month before labor. Finally six months after the original accident the mother was delivered of a normal child.

Bibliography.—1. Asherson, N.: Pregnancy Uninterrupted by Severe Burns and Double Amputation, Brit. Med. Jour., 1927, 2, 875.

Pellagra.—While the importance of the maternal diet in pregnancy has been understood by the profession for a long time, the influence of specific deficiency diseases, such as pellagra, has received scant notice. In a minority of instances (12.9 per cent) Siler, Garrison and Maceneal[1] found pellagra appearing either in pregnancy or the early months after childbirth. Among 87 pregnancies occurring in pellagrins, 18 (20.7 per cent) showed a recurrence of the evidences of the disease during gestation. The deliveries from May to August were more apt to be succeeded by such an exacerbation of pellagra. These facts must be borne in mind in the conduct of pregnancy either in districts where pellagra is common or in individuals who show or have shown evidences of this deficiency.

Bibliography.—1. Siler, J. F., Garrison, P. E., and Maceneal, W. J.: The Relation of Pregnancy and Childbirth to Pellagra in Women, Arch. Int. Med., 1917, 19, 404.

Lead Poisoning.—As an occupational disease plumbism has held a vantage point in professional interest for centuries. The relation of this condition to procreative difficulties of various orders has been the subject of many clinical observations and reports, of which Paul[1] made one of the most comprehensive. He observed that metrorrhagia with abortion from the third to the sixth month occurred in a high percentage of mothers. Premature delivery of nonviable children or high mortality in the early months of life proved the rule in his experience. His observations showed that the dangers to the offspring were somewhat less marked when the father was the parent exposed to lead. This circumstance he explained by the longer exposure of the fetus to the toxic maternal influence. Paul's statistical data convincingly fixed the terrible threat of lead poisoning to fetal survival and integrity. Of 123 pregnancies in exposed individuals, 64 aborted, 4 delivered prematurely and 5 were stillborn. Thirty-five children born under these conditions died within three years. Lewin[2] essentially substantiated Paul's findings and made the further observation of cirrhosis of the liver in a premature infant born to a lead-exposed mother. This organ weighed 45 Gm. and its content of lead was 16 per cent. The seriousness of the industrial hazard has more recently been emphasized by Oliver,[3] who for many years attempted to exclude women from such occupations by reason of the vast increase in miscarriages and stillbirths among these workers.

The entire question was put on a firm scientific basis by the experimental work of Cole and Bachhuber.[4] Employing the method of double mating, two males exposed to one female at a given oestrus, a lower vitality and smaller size was established in the offspring of the lead-poisoned male. In

fowls there appeared to be more fertile eggs where the cock poisoned with lead was the parent; but singularly twice the number of dead embryos and almost four times the death rate in the first three weeks were established for these offspring as compared with normal controls. Weller[5] confirmed these observations and noted the definite blastophthoric effect of lead upon the male germ plasm of the guinea-pig, in which sterility was induced without a loss of sexual activity. Since the number of stillborn was out of proportion to the intoxication of the mother, he believed there existed either a specific susceptibility of embryonic tissue to lead or a blastophthoric effect on female germ plasm as well. The recovery of reproductive power in the guinea-pigs on discontinuing lead argued for a deleterious action on that portion of the germ plasm undergoing maturation rather than on the totally undifferentiated germinal epithelium.

An entirely different aspect of the question was raised by the clinical experience of Husfeldt[6] who reported jaundice and grave anemia in a woman who had taken red oxide of lead as an oxytocic agent. Neutrophilic leukocytosis, nuclear fragmentation of the erythrocytes and hyperchromemia completed the picture.

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CHAPTER XXX

TOXEMIAS OF PREGNANCY

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INTRODUCTION

The term toxemias of pregnancy concerns chiefly two conditions peculiar to the pregnant state: (1) nausea and vomiting of the early months which in aggravated form is called hyperemesis gravidarum or pernicious vomiting of pregnancy; (2) preeclamptic toxemia of the later months and its severe form, eclampsia. Chronic nephritis, although not true toxemia of pregnancy, is included in this chapter because frequently its symptoms are similar to those of preeclamptic toxemia. Other rare diseases often included among the toxemias of pregnancy are ptyalism, acute yellow atrophy of the liver, toxic psychosis of pregnancy, chorea of pregnancy, and certain toxic dermatologic conditions such as herpes gestationis. Pyelitis and pyelonephritis complicating pregnancy, sometimes classified among the toxemias, have few if any characteristics of the so-called "true toxemias," and are not considered in this chapter.

TOXEMIA OF THE EARLY MONTHS

NAUSEA AND VOMITING OF PREGNANCY

Etiology.—There has been and will continue to be much debate as to the exact cause for the phenomena related to vomiting of pregnancy. The controversy concerning etiologic factors has naturally extended to treatment, in consequence of which many therapeutic methods have been advanced, and the good results adduced as proof of the given hypotheses. It seems obvious that some direct cause must exist to explain a manifestation which accompanies, to greater or less degree, approximately 50 per cent of all pregnancies, even though in the majority the condition does not attain serious proportions. The generally accepted classification of etiologic factors has been almost purely clinical, and has consisted in dividing the patients into groups based on the conception that the disease was due to a neurosis, to some reflex stimulation, or to an essential toxemia incident to pregnancy. The idea of reflex causation is being abandoned, as a distinct group, although it is realized that conditions may exist that will aggravate the vomiting while not being the direct causative factor. In support of this contention that the condition is a neurosis, one may certainly enumerate many instances of cure or marked amelioration of the symptoms by suggestion and other treatment aimed primarily at the nervous or mental condition. The endocrine glands individually and collectively have been considered in the etiology and their extracts employed in treatment. Among others, Frankel and Seitz have sponsored this idea. Probably the outstanding

example of this treatment has been the use of corpus luteum extract as advocated by Hirst. He reported relief of symptoms in a high percentage of cases. Opitz expressed the belief that the initial vomiting of pregnancy of certain sensitive women is due to withdrawal of nourishment for the fetus which leads to a more or less marked condition of starvation. Others have considered that the condition is due to absorption of food in the early stage of digestion. Lévy-Solal is inclined to the belief that the condition arises from sensitization of the mother to placental extract. It has been suggested that intoxication occurs from the setting free of fragments of villous tissue in the maternal circulation. As will be readily seen, these ideas are based largely on clinical experience, and as Williams aptly put it, will have to be considered as tentative.

In the last ten years, largely through the work of Duncan and Harding, Titus and his co-workers,[135-138] and Thalheimer, attention has been directed to another hypothesis to explain emesis and hyperemesis gravidarum, that of deficiency of carbohydrate. Although this has resulted in considerable controversy as to the exact interpretation of clinical and laboratory data, it has been the basis for successful treatment of many severely sick patients.

As Stander[121] stated, it seems most likely that a metabolic disturbance, and in particular perhaps an upset in the carbohydrate metabolism, which in turn leads to incomplete exidation of fatty acids, plays a part in the different manifestations of this toxemia in the early half of gestation.

It would seem safer to consider that all emesis and hyperemesis has a common cause, and that no satisfactory distinction can be made between "neurotic" and "toxic" vomiting. Any combination of symptoms or rate of progress may occur; hence, the widely varying types of disease.

Pathologic Anatomy.—Since Ewing and Stone drew attention to the hepatic changes which had occurred in many women who had died of hyperemesis, it has generally been considered that central necrosis of the liver was to be expected. This change cannot, however, be deemed characteristic of the condition, for there are cases on record in which this central necrosis was not present, or in which other changes, such as extensive fatty degeneration of the liver, were present. It is not surprising that various pathologic pictures are seen at necropsy because of the greatly varying symptoms of the disease. Lesions found in other organs, the kidneys for example, are of degenerative nature and not necessarily typical of hyperemesis gravidarum.

Symptoms.—The common experience of the patient is to be nauseated in the morning, either on awakening or on first getting up. The stomach is emptied, breakfast is taken, and the woman experiences no further trouble until the next morning. In other cases the nausea and vomiting recur as the stomach becomes empty, to disappear on intake of food. It is often noticed that fatigue and excitement will aggravate the symptoms.

There may occur a gradual increase in the frequency of emesis, and nausea may become almost a constant sensation. Fluids as well as food are not retained. Anorexia appears; even the sight and smell of food aggravate the condition. The character of the vomitus varies, undigested food is returned, and there may be mucus tinged with bile and occasionally streaked with blood, if there has been much retching. Loss of strength, nervousness, sleeplessness, and general indisposition ensue.

The clinical picture manifested by the patient with hyperemesis, when

the condition has proceeded beyond the mild stage, varies considerably. There is an obvious loss of subcutaneous fat. The skin is often dry, inelastic, and wrinkled. The eyes not infrequently are sunken. The patient is restless, irritable, and in many instances there is constant retching with or without vomiting; the mouth is dry, the tongue may be cracked, although sometimes there is excessive salivation; not infrequently the oral hygiene has been very much neglected, the pulse may be rapid, although Pinard's dictum that a pulse rate of more than 100 beats each minute denotes a seriously sick patient does not seem tenable. Many patients in an advanced stage of the condition are seen without this finding, and conversely many patients are seen with more marked elevation of pulse rate, whose response to treatment is prompt. The blood pressure is usually low, in keeping with the patient's general asthenic state. The breath not infrequently has an acetone-like odor; icterus may or may not be present; not infrequently a patient with marked hyperemesis may present a slight icteric tint of the sclerae when first seen, and this may be considered as evidence of a rather advanced condition. This may clear up promptly under intensive treatment, so that icterus seen under these conditions is not necessarily an extremely adverse sign. On the other hand, a patient who has been under intensive treatment, and who does become jaundiced, is probably not making a satisfactory response.

The terminal stage of the condition finds the patient with marked loss of weight, and very dry skin and mucous membranes. Slight persistent increase in temperature may appear. Jaundice, if not previously in evidence, may make its first appearance, and if present, increases. The patient may be semicomatose or irrational. Attempts to empty the stomach are nearly continuous, although occasionally the vomiting ceases. Toxic retinitis may appear, causing impairment of vision. When this stage is reached, the time even for interruption of pregnancy is past. Unalterable changes in the tissues have occurred and recovery is usually impossible.

Diagnosis.—The diagnosis of emesis or of hyperemesis gravidarum depends on the positive determination of a pregnant state and the exclusion of causes for vomiting other than pregnancy. The onset of morning sickness usually occurs between the fourth and the eighth week, and may last for from six to twelve weeks; rarely, vomiting persists throughout the period of gestation and, still more rarely, the condition runs a very rapid course, and a very sick woman may be seen after two or three weeks.

The presumptive signs of pregnancy, amenorrhea and changes in the breasts, are usually present in addition to nausea and vomiting. The positive diagnosis of early pregnancy by a single pelvic examination is often uncertain. If time permits, repeated examinations by means of which changes in the size, shape and consistence of the uterus can be noted, will enable a diagnosis to be made. The hormone test for pregnancy has proved almost 100 per cent accurate under controlled conditions and may be employed if the diagnosis is doubtful. A positive reaction is of definite value. A negative reaction, however, should not be considered definite unless a repetition in two weeks corroborates the first negative test. One must keep in mind diseases which may in themselves produce a similar clinical picture as well as those which may coincide with pregnancy, and which could explain the nausea or vomiting, or aggravate it. Disease of the gallbladder is not uncommonly encountered during pregnancy, and may produce the first symptoms at that time. If

the appendix is diseased, not uncommonly the condition is aggravated during early pregnancy. The part that disease of these organs plays in the production of nausea is well known. Such conditions as duodenal ulcer, gastric ulcer, gastric carcinoma, or tuberculous peritonitis are not often encountered in association with pregnancy, but the fact that they have been reported and may be the cause of nausea and vomiting should be kept in mind. Acute pyelitis is a not uncommon complication of pregnancy and often is accompanied by vomiting, particularly if associated with urinary obstruction. One occasionally encounters a case of acute hyperthyroidism in early pregnancy in which the clinical picture simulates severe hyperemesis gravidarum; the elevated basal metabolic rate and response to compound solution of iodine will determine the diagnosis. Such conditions as anorexia nervosa and migraine can occur in association with pregnancy, and their usual manifestations may be intensified. There are women who vomit from very minor stimuli, and the condition naturally carries over into the pregnant state. They do not, as a rule, manifest serious derangement of nutrition. Their condition falls into a group termed "gastric neurosis" or perhaps better called "functional vomiting"; such patients can be encountered in any field of medicine.

Laboratory examination has not been as helpful in determining the stage of the disease and the prognosis for the patient as one might desire. Stander[120] has expressed the belief that the most outstanding chemical changes accompanying serious vomiting of pregnancy are high ammonia coefficient in the urine, slight increase in the nonprotein nitrogen in the blood, a decrease in the blood chlorides and an increase in the uric acid, amino-acid and lactic acid, with a marked accumulation of acetone bodies in the blood stream. Dehydration, starvation, and incomplete oxidation of fatty acids following a disturbed ketogenic and antiketogenic ratio undoubtedly play important parts in the production of these chemical changes. Dieckman and Crossen, in stating their conclusions concerning laboratory examinations, expressed the belief that severe vomiting of pregnancy is characterized by normal or increased values for carbon dioxide combining power of plasma, for p_H of blood, and for nonprotein nitrogen of blood; by low normal or decreased values for sodium chloride of blood and for plasma protein. Neither observer agrees with Titus that hypoglycemia exists. Van Wyck attached considerable significance to the amount of serum protein present. He concluded, from study of a series of fifty-five patients, that the general high level of serum protein indicated concentration brought about by hyperemesis. The majority of patients whose values for protein were high were those who yielded most promptly to intensive treatment. On the other hand, when a low value was obtained, the condition had usually been established for some time, and when the clinical signs of dehydration were present the prognosis was serious. Van Wyck expressed the view that for patients with markedly lowered values for serum protein, simple replacement of lost food will not suffice. There must also be regeneration of serum protein before complete recovery is possible. This author stated further that 80 per cent of patients with hyperemesis have urobilinuria, and that in those cases in which response to treatment is obtained, this soon disappears, whereas in cases of persistent urobilinuria a more severe grade of the condition exists. The response of the patient to increased intake of fluid is probably of some prognostic value,

although this naturally must depend on the amount of fluid given. Harding and Van Wyck[30,31] stated that those patients who respond to treatment by a large output of urine improve clinically, as a rule. They said, likewise, that when the patient is first seen, the quantity of urine passed in twenty-four hours is a helpful guide by which to judge the severity of the condition and the necessity for treatment in bed. If they obtained a urinary output of at least 1000 cc. in twenty-four hours, with a specific gravity of not higher than 1.010, it was considered evidence of response to treatment. If this was delayed longer than a week it was taken, together with other unfavorable clinical signs, as an indication for abortion. Naturally the patient's urinary output is related to the intake of fluid, and unless fluids are forced, diuresis will not occur. From our experience, 3000 cc. of fluid daily is the minimum to be considered in treatment of these patients.

Treatment.—The treatment in these cases can be based best perhaps on the idea that hyperemesis gravidarum is a condition with a definite tendency to pass through stages of increasing severity, and that practically all women suffering from advanced degrees of the condition have had mild symptoms earlier in gestation. The exception to this may exist in those rare instances of a very rapid downward course, with early evidences of dehydration and starvation, and the early appearance of signs of hepatic injury. This being true, it would seem safer to consider each pregnant woman who experiences sufficient vomiting to bring her to the physician for advice, as one whose condition may progress to serious illness. One cannot, of course, acquaint the patient with this progressive tendency of the condition, for reassurance and an attitude of confidence are essential in the treatment.

Recognition of the disease and institution of a definite regimen in the early stage is fundamental in the treatment. This is proved by the large percentage of patients with mild symptoms who respond, and in whom there is no further advance of the condition after institution of treatment. It is impossible, at present, to identify accurately, as a rule, the patient whose condition will progress to the severe stage of hyperemesis, in which definite signs of serious interference with metabolism will be evident.

The need of prophylactic or preventive treatment in obstetrics cannot be overemphasized. Unfortunately the obstetrician is unable to see many of his prospective patients before pregnancy and subject them to a complete examination. Were this possible, many factors which, no doubt, act as direct or aggravating factors, could be detected and eradicated before pregnancy occurs. The effect, for example, of foci of infection in relation to systemic disease is well known. These foci may exist for a long time with no evidence of symptoms, but under increased conditions of stress and strain, as in pregnancy, they may begin to give evidence of trouble. The question of organic or functional conditions of the gastro-intestinal tract is more easily determined prior to pregnancy and, if known or excluded, the subsequent symptoms of emesis or hyperemesis are more intelligently interpreted. It is to be hoped that members of the medical profession, and laymen, may ultimately come to realize the great value of general examination before pregnancy is undertaken.

As mentioned before, the theory that reflexes are concerned in the etiology of hyperemesis is being abandoned. Apparently it must be admitted, however, that physical conditions exist which may aggravate the condition. In review-

ing the literature on the treatment of hyperemesis gravidarum, one finds attention frequently drawn to associated lesions. The chief difficulty in evaluating treatment of the lesions lies in the difficulty of discriminating between those symptoms due to hyperemesis itself, and those due to associated lesions. Chronic cervicitis is a common gynecologic condition, and not infrequently can be found in cases of vomiting of pregnancy. Treatment of this condition, or even treatment by means of application of silver nitrate to a normal cervix, is reported to have been followed by amelioration of symptoms. Replacement of a retroverted uterus has also been followed by relief from nausea and vomiting. These results are difficult to explain but prove the point that a thorough consideration of all phases of the patient's physical condition should form a basis for general treatment of hyperemesis. Time devoted to evaluating these items is well spent in any case.

Just as important is analysis of the patient's nervous state and mental reaction. Many persons are essentially unstable, or nervously and physically inadequate, and their reaction to any stress is excessive. It is well known that fear is one of the most demoralizing emotions to be encountered, and it no doubt enters largely into this as well as many other syndromes.

One may treat patients with hyperemesis on the basis of the four factors which apparently enter into the syndrome: Nervous exhaustion, dehydration, starvation, and hepatic derangement or disturbance of carbohydrate metabolism. This summary of treatment depends on the general consideration that the condition is one of progressive stages of severity, which, although not sharply defined, tend to progress from mild to severe.

Patients with early or mild hyperemesis are usually ambulatory, and dehydration and starvation have produced few, if any, changes. If patients are adequately treated in this stage, the condition of practically none of them will advance to the more severe stage. Treatment consists of the following: (1) Correction of associated disturbances or lesions; (2) reassurance, rest, freedom from nervous and physical stress; (3) frequent, small feedings of high caloric content; (4) intake of fluid between feedings of sufficient amount to meet the requirements of the individual and to produce ample output of urine; (5) sedatives in an amount sufficient to reduce the general nervous reaction of the patient, and to combat the gastric irritability, and (6) dilute hydrochloric acid for those patients to whom it affords relief.

Patients whose symptoms are still only moderately severe, but who have lost weight, whose urine contains acetone, and who fail to respond to the foregoing measures may be treated as follows: (1) Continuance of the measures outlined in the foregoing; (2) isolation; (3) rest in bed; (4) proctoclysis, and (5) increase in sedation.

Patients with severe grades of the condition are markedly dehydrated and starvation is evident. A strict regimen may be initiated as follows: (1) Isolation, preferably in a hospital; (2) rest in bed; (3) sedatives; (4) proctoclysis; (5) intravenous administration of fluids and dextrose, and (6) duodenal feeding.

Patients who are under the foregoing regimen, may, nevertheless, have persistent emesis, persistent urobilin in the urine, icterus, fever, inadequate urinary output, and may early show evidence of increase of severity of the condition. Perhaps they have not sought medical advice until they were very ill or have the rare fulminating, rapidly developing form of hyperemesis.

resided in the hospital and after an examination received a diploma from the Faculty of Medicine permitting them to practice midwifery. In describing this school John Green Cross (1790–1850) says:[1]

"L'Hospice de la Maternité has been formed from the ruins of the old Foundling-Hospital since the Revolution, and is an institution for the delivery of pregnant women as well as the reception of deserted infants. There are separate buildings for these two purposes, the one called *Section d'Allaitement*, the other *Section d'Accouchement;* but both are under the same administration and are supported by government.

"The midwifery department of l'Hospice de la Maternité is converted to an admirable purpose by being made a school for the educating of *Sages-femmes;* and I was not a little surprized at my first entering this hospital with M. Chaussier the chief Physician, to find the wards crowded with female students. This midwifery-school was founded about twelve years ago, since which time young women have come annually from all parts of France to study there. Some pursue their education at their own expense; but most of them are chosen by the *Préfets* of the different departments, or the governors of country hospitals, by whom all expenses are paid. For six hundred *francs* these women are lodged, boarded and educated, during one year. They reside in the hospital, and cannot go out of its precincts, without permission. After twelve-months residence, and an examination, they receive their diplomata from *l'École de Médecine* to practice as midwives. Besides being practically engaged in the management of natural labors, they attend lectures given twice a week at the hospital by the Professor to *l'École d'Accouchement.* They also receive instruction daily from the *Sage-femme en chef* of the hospital, and attend the course of midwifery given exclusively to them at *l'École de Médecine.* They follow the Physician and Surgeon in their daily visits, and each *elève* makes a clinical report in writing of the patients under her care."

Cross further notes that these women were not only given didactic instruction and demonstrations in anatomy, but were required to attend the postmortems of all women who died in the hospital. They were also instructed in the technic of vaccinating against smallpox and in bleeding. He notes that in the first five years nearly five hundred well-trained women were sent to practice midwifery in different parts of France. He further states that this plan did honor to the country that had founded and supported it, and he believes that these women when graduated were quite as good practitioners as were the male students of midwifery in any country.

Much of this development was due to the enthusiasm and interest of Baudelocque. In this connection Baudelocque published in Paris in 1775 a manual of instruction for midwives and it is related that the French government purchased six thousand copies for general distribution among practitioners of midwifery.

Seconding Baudelocque and assisting him in every way possible in this school was Madame **Louise Dugès Lachapelle** (1769–1821). Her mother, Madame Dugès (née Marie Jonet)—a professional midwife—had been made midwife-in-chief to the Hôtel Dieu in 1775; her father was Louis Dugès, health officer in Paris. In 1792 Marie Louise Dugès became Madame Lachapelle, the wife of the resident surgeon of the Hôpital Saint-Louis. The death of her husband occurring shortly after their marriage (1795) the widow Lachapelle took up the study of midwifery and became so expert in her duties at the Hôtel Dieu, that in 1795 she was made associate chief midwife. When the Maison d'Accouchement was organized, Madame Lachapelle was made resident directress, and under Baudelocque was the first instructor in midwifery.

[1] *Sketches of the Medical Schools of Paris.* London, 1815.

and in 2 of 12 cases of severe preeclamptic toxemia chronic nephritis developed. Examining patients one year postpartum, Harris found that 3 of 27 patients who had had eclampsia, and 60 per cent of 55 patients who had had severe preeclamptic toxemia showed definite signs of chronic nephritis. Peckham observed that 12.2 per cent of primiparas, and 39.3 per cent of multiparas had nephritis following preeclamptic toxemia. In his cases nephritis did not subsequently develop when the systolic blood pressure remained less than 170 mm. of mercury. When the systolic blood pressure was between 170 and 200, 15 per cent of the patients had nephritis, and when it was more than 200, 48 per cent had nephritis. Rockwood, Mussey, and Keith reported 57 cases in which chronic nephritis developed as a result of preeclamptic toxemia.

Symptoms and Diagnosis.—Many cases of chronic nephritis are discovered only when the pregnant woman presents herself for prenatal examination, although most of those caused by acute toxemia can be detected at postnatal follow-up examination. "Occult" chronic nephritis may escape detection at one or more prenatal examinations and the presence of preexisting nephritis may be suspected only because hypertension and albuminuria have appeared comparatively early in gestation. If prenatal examination reveals evidence of edema or hypertension, if albuminuria is present, or if there is a history of previous renal trouble, further tests are made. Increase of the concentration of nonprotein nitrogen or of urea in the blood, or prolonged retention of phenolsulphonphthalein, is evidence of lowered renal function. If renal function is definitely curtailed, the specific gravity of the urine is relatively fixed. The urine of a normal person on a dry diet will be concentrated and the specific gravity should rise to 1.025 or more; conversely, following drinking of a quantity of water in a short space of time, the specific gravity of the urine should be lowered to at least 1.003. Following Volhard's plan: Two days are set aside for determining the upper and lower limits of the specific gravity of the urine. For the concentration test, the patient is given food for a day, consisting of 20 per cent solids only; no fluids are given. The urine is collected at intervals of three hours. The specific gravity should reach 1.025. In the water, or dilution test, 1500 cc. (7.5 glasses) of water are given on a fasting stomach between 8 and 8.30 A. M. The urine is collected every half hour for the next four hours. The normal output varies between 1200 and 1800 cc. and the specific gravity should be as low as 1.003. The ocular fundi are examined for evidence of previous "albuminuric retinitis" and for the appearance of fresh "retinitis."

Various findings which may be present in chronic nephritis appear in the following outline: Hypertension, with systolic blood pressure of 140 or more, and diastolic blood pressure of 90 or more; edema, graded 1 to 4; albuminuria graded 1 to 4; casts and erythrocytes in the urine; specific gravity fixed or low; lowered renal function as evidenced by retention of nonprotein nitrogen in the blood, increase of inorganic sulphates in the blood serum, or by decrease in output of phenolsulphonphthalein after intravenous injection, and changes in the ocular fundi known as albuminuric retinitis.

A simple, rapid, clinically accurate method of estimating albuminuria in terms of milligrams of albumin in each 100 cc. of urine, which requires only a burner, a test tube, and a reagent such as acetic acid, is given in Table I.

TABLE 1

GRADING OF ALBUMINURIA*

Albumin, grade.	Effect of addition of reagent to urine.	Mg. of albumin for each 100 cc. of urine.
0	No cloudiness	0
1	Faintest trace of cloudiness up to definite cloudiness	1 to 20
2	From definite cloudiness until finger is obscured when placed behind tube	21 to 60
3	From obscuring of finger until urine becomes thick or curdled	61 to 90
4	Definitely thick, curdled urine	91

* This grading is used at the Mayo Clinic.

A pregnant woman who has chronic nephritis may exhibit a typical syndrome of headache, edema, secondary anemia, hypertension, and albuminuria, with the urinary specific gravity fixed or low, with increased retention of nonprotein nitrogen in the blood, with evidence of retinitis, and with visual disturbances. The most constant signs in less severe cases are hypertension, albuminuria, and fixed or low specific gravity. Ocular signs are more likely to be present when the chronic nephritis has followed an acute attack rather than appearing as part of an insidious, slowly developing disease.

Hypertension is not necessarily an evidence of chronic nephritis. Hypertension of the so-called "benign type" may be present without evidence of an arterial or renal lesion, although high blood pressure, even in the absence of a renal lesion, may be due to more or less serious arterial and arteriolar changes. It may even simulate chronic nephritis or toxemia of pregnancy, as in the following case:

A woman, aged forty-nine years, came under our observation for the first time in April, 1920, in the seventh month of gestation. She had seven children living and well. For the previous two weeks vision had been failing progressively. The systolic blood pressure was 225 and the diastolic, 140. Albumin graded 3, hyaline casts graded 3, and pus graded 1, were noted in the urine. Renal function was normal. The ocular fundi gave evidence of marked albuminuric retinitis. Following induction of labor, a living child was delivered and the patient recovered uneventfully. Subsequently she was observed by us on numerous occasions, on account of partial blindness, partial hemiplegia, and persisting hypertension. She died suddenly in 1928. Necropsy revealed cardiac hypertrophy, with slight evidence of arteriosclerosis. There were multiple old and fresh cerebral hemorrhages, but evidence of nephritis or of hepatic disease was not found.

Conversely, women with benign hypertension antedating pregnancy may pass through pregnancy without any appreciable increase of hypertension or other evidence of toxemia. However, the question of preexisting renal insufficiency must be seriously considered, when a woman in the early months of pregnancy is found to have a systolic blood pressure of 140 or more on several readings.

A slight trace of albumin in the urine is apparently not of consequence, but when this becomes more than a trace, or 21 mg. or more to each 100 cc., and is found on subsequent examinations prior to the fifth month, preexisting

renal injury may be strongly suspected. When albumin is found in the urine, microscopical examination should be made of a centrifuged specimen to determine the presence or absence of casts, erythrocytes, and pus cells. Albuminuria may not definitely indicate renal disease, for positive tests for albumin may be due to the presence of pus resulting from inflammation of the urinary tract or from soiling of the urine with vaginal discharge. In case of doubt, a catheterized specimen should be examined. Occasionally, renal insufficiency may be associated with pyelitis or pyelonephritis complicating pregnancy. Close observation of the doubtful case, as pregnancy progresses, may reveal increasing hypertension, albuminuria, and edema, occurring much earlier in pregnancy than do symptoms of acute toxemia.

Some very mild cases can be controlled by treatment, but usually the symptoms are progressive, with increasing albuminuria, oliguria, and edema. If the specific gravity of the urine is low, the output is generally free and less edema develops. In the more severe cases the patient complains of constant headaches and visual disturbances, such as spots before the eyes, haziness, and lowered acuity of vision. In these cases the value for nonprotein nitrogen of the blood is usually increased. The condition may steadily progress until uremic convulsions develop. More commonly, before these grave symptoms appear, the fetus dies in utero or the patient goes into labor prematurely.

Prognosis.—Chronic nephritis is a serious complication of pregnancy, more immediately serious for the fetus than for the mother. Generally speaking, the prognosis for the mother becomes worse with each succeeding pregnancy, and the morbidity of chronic nephritis extends beyond the period of pregnancy. A number of cases of well-marked chronic vascular or renal injury following pregnancy was observed by Rockwood, Mussey, and Keith at varying intervals, in some instances ten or more years after pregnancy. Thirty-two of the patients were traced over a period of two and a half to three and a half years, during which time nine died of the disease. The lesions in these cases were diagnosed as chronic glomerulonephritis in 12 cases; chronic nephritis (unclassified) in 7 cases; malignant hypertension in 4 cases; and benign hypertension in 9 cases. The highest mortality was in the first three groups. These 32 women gave histories of having had 54 living children, 9 premature stillbirths, 26 miscarriages, and 2 induced abortions. Litzenberg has emphasized the point that next to syphilis, nephritis is the commonest cause of repeated premature labor or stillbirths. Some women pass through pregnancy with little if any exacerbation of mild chronic nephritis. However, if there is clear evidence of chronic nephritis, the patient should be advised against future pregnancy, or if she is pregnant should be warned of the danger of continuance of pregnancy.

Treatment.—A certain diagnosis of chronic nephritis in the course of pregnancy places on the medical attendant the responsibility of informing the patient of the condition and its risks. When the disease is of severe grade, or when there is a history of a definite exacerbation in the course of a preceding pregnancy, termination of pregnancy should be advised. Rising blood pressure, increasing albuminuria with or without edema, and especially changes in the ocular fundi are symptoms which indicate the advisability of immediate or early termination of pregnancy. If the disease is of very mild grade, or if the diagnosis is in question, sometimes the patient may be carried along under careful observation and medical measures.

An important feature of the treatment is a trial period of rest in bed for ten to fourteen days. During this time the patient is given a salt-free diet of 1500 calories containing 50 mg. of protein daily. Occasionally this will be followed by a fall in blood pressure and lessening of albuminuria. In such cases, under a careful regimen of rest and diet, pregnancy may be carried to successful completion without increase of nephritic symptoms. It is difficult to establish a definite rule as to when treatment, rather than interruption, is justified. In general, it may be said that conservative measures are not indicated in the face of definite chronic nephritis, if the systolic pressure remains in excess of 160, if the albuminuria is of more than grade 2 or if edema does not decrease. An increase beyond normal of nonprotein nitrogen in the blood, or the appearance of "fresh" retinitis, indicates failure of conservative measures.

PREECLAMPTIC TOXEMIA

The "true" toxemias of the later months of pregnancy which result from a toxin, or toxins, or toxic substances as yet unidentified, furnish a syndrome of symptoms peculiar to the condition. Evidence indicates that these forms of toxemia are caused by a common agent which affects tissues throughout the body, and that the resultant symptoms usually pass through various stages. In most of the severe cases the onset is mild or comparatively mild, although most of the mild cases never become severe. Occasionally, in some severe cases there is an abrupt onset of serious symptoms. The symptoms produced, whether mild or severe, differ with the organ or organs chiefly involved. This variance both in degree and character of the symptoms, and in the extent of the pathologic lesion which affects the involved organs, has led to various classifications of these forms of toxemia, from the standpoint of symptoms and pathology. None has received universal acceptance, and consideration of them all seems unnecessary.

Forms of toxemia which are commonly included under the term "preeclamptic toxemia" may be divided into mild preeclamptic toxemia; severe preeclamptic toxemia or preeclampsia, and eclampsia with convulsions.

Stander[121] proposed and Williams adopted the term "low reserve kidney" to define forms of preeclamptic toxemia of milder degree. Stander[121] pointed out that physiologically all the glomeruli in the kidneys are not functioning at capacity, and that there is an estimated 50 per cent margin of safety which may be called kidney reserve. He expressed the belief that "in certain individuals such kidney reserve may be greatly decreased, due either to congenital causes or to factors which may have lessened the number of functioning glomeruli without producing chronic nephritis." When such a patient with low kidney reserve is subjected to the extra demands of pregnancy, mild symptoms of renal insufficiency result. Stander[121] has clearly and accurately described the clinical symptoms and laboratory findings in the mild type of preeclamptic toxemia. It seems evident, however, that a toxic factor operates in mild as well as in severe forms of preeclamptic toxemia. Exclusive of the symptoms produced by the exacerbation of preexisting chronic nephritis or arterial disease, no definite proof has been produced that lowered physiologic reserve of the kidneys or other tissues is the cause of either mild or severe types of preeclamptic toxemia. Although many of the mild forms of preeclamptic toxemia do not become severe; the question

arises whether it is safe to assume that preeclamptic toxemia is not a progressive disease which may proceed from mild to severe stages. The term, "mild preeclamptic toxemia," descriptive of the group in which slight hypertension and albuminuria predominate, is used in this classification of preeclamptic toxemia to emphasize the presence of the toxemic element and the potentially progressive course of the condition. The mild forms of preeclamptic toxemia may include conditions described by the term "albuminuria of pregnancy," which is still used in governmental statistical reports and by some European observers. "Recurring toxemia," "low reserve kidney," "acute nephrosis," and "acute glomerulonephrosis" are other terms that may be more or less equivalent. Since treatment in this group is much the same, irrespective of the exact terminology, the chief use of classification is merely a rack on which to hang the symptoms and findings of the mild, severe, and convulsive forms of the disease.

The relative incidence of the various forms of toxemia among patients admitted to an obstetrical hospital through a well-conducted prenatal clinic has been described by Stander,[121] as in Table 2.

TABLE 2

INCIDENCE OF DIFFERENT FORMS OF TOXEMIA AMONG 8585 ADMISSIONS TO JOHNS HOPKINS CLINIC (STANDER)

Type.	Cases.	Per cent of total number of cases of toxemia.	Incidence in total number of admissions.
Vomiting	76	9.5	1 to 113
Low reserve kidney	277	34.6	1 to 31
Nephritis	214	26.7	1 to 40
Preeclampsia	74	9.2	1 to 116
Eclampsia	100	12.5	1 to 86
Unclassified	60	7.5	1 to 143
Total	801	....	1 to 11

Symptoms and Diagnosis.—The classical symptoms of preeclamptic toxemia are high or rising blood pressure, albuminuria, and edema, usually with undue gain in weight. These signs are associated, in the more severe forms of the disease, with progressive symptoms of headache, dizziness, disturbances of vision, epigastric pain, and finally, eclampsia with convulsions. In the majority of cases these symptoms do not become severe. In others the onset of alarming symptoms may be abrupt. Frequently, among patients with eclampsia who have not been under prenatal observation, the first symptom noticed by the patient, aside from edema, may have been the severe headache directly preceding the first convulsion.

The large majority of patients with preeclamptic toxemia will no doubt continue to come under the care of physicians some of whom may not have available laboratory facilities, aside from apparatus for urinalysis and the microscope. As a matter of fact, the diagnosis of preeclamptic toxemia depends chiefly on recognition and evaluation of symptoms, on readings of

blood pressure and on urinalysis, rather than on more elaborate laboratory equipment and procedures. When symptoms are progressive or when the patient's condition is alarming at the first examination, hospitalization, with its more adequate equipment, usually can be obtained.

The onset of symptoms of preeclamptic toxemia is usually insidious. Adair and other observers have stated that an incipient rise in blood pressure is the earliest sign of beginning preeclamptic toxemia. The systolic blood pressure of the pregnant woman often will be lower during the first three months than that of the average nonpregnant woman, usually below 120, more often in the neighborhood of 110. After the third month the pressure gradually rises to 120, and sometimes to 130. If the systolic blood pressure of a pregnant woman rises to 140 or more, with no clinical history or findings of chronic nephritis, the onset of preeclamptic toxemia should be suspected. In fact, some observers feel that if the systolic pressure has remained below 120, a rise in pressure to 135 may be the first indication of preeclamptic toxemia. This is especially likely to be true if the woman is in her first pregnancy and is less than twenty-five years of age. This rise in blood pressure is likely to occur early in the third trimester, or about the twenty-sixth or twenty-seventh week. The time of the first appreciable rise in systolic blood pressure is an important differential point between true preeclamptic toxemia and chronic nephritis, for in the latter condition the rise in blood pressure almost invariably occurs prior to the third trimester and often in the fourth or fifth month of pregnancy. In more severe cases of acute preeclamptic toxemia, the rise in blood pressure may be abrupt and marked, and may not occur until the last few weeks of gestation. When the systolic pressure remains less than 150 or 160 the preeclamptic toxemia is usually considered to be of a relatively mild type, whereas a pressure of 170 systolic, or more, indicates more severe toxemia. In a measure, after the systolic blood pressure has reached 160 each successive rise of 10 mm. is an indication of the progressive severity of the disease. However, a systolic blood pressure of less than 150 or 160 does not indicate complete freedom from the danger of eclamptic attacks, for fatal eclampsia has occurred in the presence of comparatively low pressure. A rise of diastolic pressure also occurs, but this rise is less marked than that of the systolic pressure. It may be roughly estimated that the diastolic pressure will rise 5 points for each rise of 10 points in systolic pressure. A rise of diastolic pressure exceeding this ratio usually indicates exceptionally severe toxemia. High readings of blood pressure, or a single reading taken at a given time, are not always indicative of the severity of the toxemia. The patient may have benign hypertension which existed before pregnancy, with or without a superimposed toxemic factor. Also, the systolic pressure of a patient who is excited, or who has hurried to the examination, may be unduly high or a false low value may be obtained after rest in bed, after free catharsis, or other medication or following shock.

Albuminuria is so commonly present in the acute forms of preeclamptic toxemia that it was formerly considered of primary importance as an indication of the onset and severity of the toxemia; the term "albuminuria of pregnancy" was commonly used to designate forms of preeclamptic toxemia of the later months. The presence of albumin in the urine follows closely the rise in blood pressure, and the amount of albuminuria is often an indicator

of the severity of the process. However, a rise in blood pressure may occur and persist throughout pregnancy with no apparent evidence of renal disease. Albuminuria graded 1, or a faint trace of albumin does not present any great significance. Albuminuria may be *accompanied by the presence of* casts and of erythrocytes and pus cells. When pus cells are present it is advisable to obtain a catheterized specimen, for the pus may be due to soiling from leukorrheal discharge. Occasionally, a large amount of albumin is present in the urine, with no erythrocytes and without an appreciable rise in blood pressure. Volhard applied the term "nephrosis" to this condition, for he believed the albuminuria was due to degenerative changes in the tubules, and that the absence of hypertension and erythrocytes seemed to indicate little if any involvement of the glomerular capillaries. The terms "acute nephritis of pregnancy," "glomerulonephritis," or "glomerulonephrosis," have been used to describe the renal lesion of acute preeclamptic toxemia in the presence of hypertension, edema, and albuminuria, with or without erythrocytes in the urine.

Edema of varying degree and extent is a constant symptom of preeclamptic toxemia. Making its initial appearance in the feet and legs, it may be evident only in the evening, disappearing after rest in bed. Edema, however, is not pathognomonic of preeclamptic toxemia, for it may be due to other factors, such as pressure in the pelvis partially obstructing venous or lymphatic flow from the legs, or to physiologic chemical disturbance, or to cardiac insufficiency. Unilateral edema is rarely significant of a preeclamptic toxemic process. Edema of the feet and legs is indirectly a valuable clinical sign, for concern over it frequently causes the patient to consult a physician for her first prenatal examination. When edema is more generalized, involving the hands, arms, face, and so forth, it becomes an important visible symptom of the presence of some factor interfering with the normal excretion of fluid from the body. According to Elwyn, ordinarily the tissues can hold an excess of 5 or 6 liters of fluid before edema makes its appearance. It was formerly thought that edema was due only to renal insufficiency. Epstein and Volhard have expressed the belief that edema is due to insufficient output of water by the kidneys, and to retention of fluid in the tissue cells. Retention of fluid in the tissues is accompanied by lessened output of urine, and it usually follows the appearance of albumin, graded 2 or more, in the urine. Sometimes, slight, generalized edema may precede the appearance of albumin. In fact, it may occur without any accompanying rise in pressure, indicating the usual preeclamptic toxemic process. Wieloch has called attention to what he terms "hidden edema," in which there may be an accumulation of fluid in the tissues, with little if any visible edema aside from a sensation of fulness in the skin of the hands and feet, and alteration in the features, giving the face a heavy, gross appearance. The degree of generalized edema is often a fair index of the progress of preeclamptic toxemia; edema of severe grade indicates advancing preeclamptic toxemia. Among patients with eclampsia, convulsions are likely to be fewer and less severe when the edema is more marked; also, eclamptic convulsions may occur when there is not any edema.

Zangemeister stated that excessive gain in weight due to retention of fluid in the tissues may be the first indication of preeclamptic toxemia. Pregnant women who do not restrict their diet almost invariably gain too much

weight. It is in this group of cases that most of the instances of preeclamptic toxemia are found. This has been noted so frequently that rapid gain in weight, especially in the third trimester, even in the absence of hypertension and albuminuria, should lead to suspicion of the onset of preeclamptic toxemia. Randall reported observations of the gain in weight of primigravid patients and noted that the average gain of those who become victims of preeclamptic toxemia was 33 pounds, whereas the nontoxemic patients gained an average of 22 pounds.

Evidence seems to indicate that the same toxic factor or factors produce all types of preeclamptic toxemia of the third trimester. Probably all of the following have a common etiologic factor: (1) Mild preeclamptic toxemia, with nephritic symptoms predominating, (2) more severe preeclamptic toxemia, in which hypertension and albuminuria become more marked, and (3) eclampsia with convulsions, which seems to be a climax to the more severe cases of preeclamptic toxemia. There is much to suggest that there is produced a widespread vascular disease affecting the smaller blood vessels throughout the body. Vascular changes can be demonstrated by direct capillaroscopy of the capillaries of the nail fold, and also by inspection of the arterioles of the ocular fundi during the course of preeclamptic toxemia. Hinselmann, Heynemann, Linzenmeier, Baer and Reis, and others have noted distortion of capillaries of the nail fold, with elongation of loops and more or less capillary stasis. The arterioles are changed in size and give evidence of spasm, with areas of contraction and dilatation. Hinselmann and Nettekoven and Silberbach found changes in capillary circulation in 80 per cent of 25 cases of eclampsia. Kylin found identical changes in the capillaries of nonpregnant persons suffering from acute glomerulonephritis, and in the capillaries of women with toxemias of pregnancy, who had symptoms of nephritis.

Cheney has noted the presence of retinitis in association with toxemia of pregnancy. In a personal communication Wagener stated: "He has repeatedly observed the presence of retinal changes in preeclamptic toxemia and that retinal changes can occur in any form of toxemia in which there is significant rise in blood pressure. The discovery of retinal changes indicates the presence of some process affecting the general arterial system, and the type and severity of the retinal lesions furnish an index to the type and severity of the injury to the systemic arterioles. The presence of retinitis does not necessitate the diagnosis of nephritis, but it is identical with the retinitis found in cases of acute nephritis of nonpregnant persons. It does indicate that the arterioles of the kidneys are probably affected, and that if this condition persists the definite injury which follows will become permanent, and renal insufficiency will result.

"In cases of toxemia of pregnancy with associated rise of blood pressure, changes are seen both in the retinal arterioles and in the retina proper. The changes in the arterioles are first to appear. The changes in the retina proper, commonly spoken of as 'retinitis,' are secondary to and apparently dependent on the changes in the arterioles. The caliber of the arterioles becomes narrowed and the lumen is reduced, due at first not to organic lesions in the walls of the arterioles but to spastic contraction and increased tonus. This condition may disappear entirely if there is early and permanent fall in blood pressure. If the toxemia continues, however, the constriction soon

becomes fixed and severe. When the constriction becomes sufficiently fixed and severe in some arteriole to cause secondary capillary ischemia or stasis, localized edema and hemorrhage appear in the neighboring retina. With continuance of the toxemia this spastic constriction ultimately may become so generalized and severe as to produce diffuse retinitis of albuminuric type, the classical 'retinitis of pregnancy nephritis.' The rapidity with which the retinal changes pass through these various changes depends on the severity of the toxemia.

"The main value of examinations of ocular fundi in cases of toxemia of pregnancy is first to determine the presence or absence of involvement of the arterioles, and second, to judge as nearly as possible, by frequently repeated examinations, when the spastic constriction is becoming sufficiently severe and persistent to produce organic changes in the walls of the arterioles and diffuse retinitis. Appearance of a single hemorrhage or cottonwool patch is a warning sign, and recurrence and extension of these retinal lesions almost invariably indicate the beginning of permanent injury to the arteriolar system. Effort should be made to relieve the toxemia, if necessary by induction of labor, before the onset of diffuse retinitis, both to preserve vision and to maintain the integrity of the systemic and renal arterioles. It can be said that the presence of retinitis in cases of toxemia of pregnancy establishes the diagnosis of nephritis of pregnancy only if arteriolosclerotic or ischemic nephritis is meant. Examination of the retina should be an aid to prevention rather than to diagnosis of this complication.

"Detachment of the retina sometimes occurs in toxemia of pregnancy without typical retinitis. It is usually associated with hypertension, but the mechanism of its production is not as clear as is that of typical vasospastic or ischemic retinitis. The basic pathologic change seems to lie in the choroid. The local changes come on more rapidly and are usually more severe than in retinitis proper; but the ultimate visual results are usually surprisingly good. Also, these patients with retinal detachment do not seem to suffer from as much permanent injury to the arteriolar system as those who have retinitis and their blood pressure often rapidly returns to normal after delivery."

Fahr[35] has agreed with Zangemeister and Volhard that eclampsia is concerned with disease of capillaries, and this explains the edema, hypertension, and eclamptic convulsions. There are varying degrees of capillary and arteriolar involvement, depending on the potency of the toxin which attacks the vascular system, and the organ or organs most severely affected. The vascular involvement may be generalized, and renal injury may not be apparent. The vessels may return to normal after confinement, or so-called "benign hypertension" may follow, or the injury may be the beginning of progressive arteriolosclerosis, finally terminating in malignant hypertension. The constancy with which hepatic lesions are found among patients with eclampsia who come to necropsy would indicate that the liver is frequently affected also in the nonconvulsive, nonfatal forms of preeclamptic toxemia. Among those patients who recover, injury to the liver would pass unnoticed, because of the wide margin of safety which must be overcome before symptoms of hepatic injury are manifest, and because of the strong power of regeneration possessed by the liver.

With such widespread vascular involvement, the kidneys, which almost always give clinical evidence of involvement, do not always escape permanent

injury. Renal lesions may be considered to be due to changes in the capillary loops of the glomeruli that are similar to vascular changes in the nail folds and in the ocular fundi. The kidney may recover from temporary spasm and distortion of the glomerular vessels, but if the spastic constriction becomes sufficiently severe and persistent, organic changes may be produced and may lead to chronic nephritis. When the lesion extends from the glomeruli to the tubules it takes the form of the combined glomerulonephrosis described by Volhard.

The development of chronic nephritis resulting from the renal injury incurred during an attack of preeclamptic toxemia, or eclampsia, is borne out by reports of clinical observations by Harris, Peckham, Caldwell, Lyle, and others. As previously mentioned Harris found that 60 per cent of patients with severe preeclamptic toxemia gave definite signs of chronic nephritis. Peckham observed that 12.2 per cent of primiparas and 39.3 per cent of multiparas had nephritis following preeclamptic toxemia. In his cases, nephritis did not develop when the systolic blood pressure remained less than 170. Caldwell and Lyle reported an incidence of 8 per cent of chronic nephritis after eclampsia. Kellogg, Gibberd, and Mussey each reported the occurrence of chronic nephritis in cases observed after two or more attacks of preeclamptic toxemia in succeeding pregnancies. In accord with Kellogg's observations, Mussey also noted that when women who have had preeclamptic toxemia become pregnant again a large proportion (60 per cent in the group reported) will have symptoms of toxemia.

Briefly, then, during the course of preeclamptic toxemia many women manifest clinical evidence of acute vascular and renal injury. The end-result of these injuries may be summed up as follows: (1) If the injury is slight, perhaps merely a circulatory disturbance, or if there are slight degenerative changes, recovery may be complete. (2) If the injury is more severe it may become permanent, although so slight that it cannot be detected by any test of renal function now available except the test of subsequent pregnancy. (3) The injury may be sufficient to produce unquestioned chronic renal injury, or permanent injury to the general arteriolar system, or lesions both in the kidneys and general arteriolar system.

Chemical Examination of the Blood in Severe Preeclamptic Toxemia.*— Examination of the blood of patients with mild preeclamptic toxemia reveals little abnormality except increase in the concentration of blood chlorides when edema is present. This was marked in 18 per cent of the cases studied by Denis and Hobson. As a more severe stage of toxemia is reached, when the blood pressure is 170 or more, frequently other chemical changes in the blood are found. Stander and Radelet described certain changes found in severe preeclamptic toxemia and eclampsia. There were chiefly a decrease in carbon dioxide combining power, sometimes to 35 volumes per cent or less, usually more marked in the more severe cases; a high value for uric acid; a markedly increased value for lactic acid, not entirely the result of muscular activity; a definite tendency toward hyperglycemia, and an increase in inorganic phosphorus. Observing pregnant dogs, MacNider found little departure from the normal, aside from a fairly common reduction in the alkali reserve of the blood. Loesser and Bokelmann expressed agreement

* It seems advisable in this section to anticipate sufficiently to include here the values found in eclampsia.

pregnant women had no other accommodation than the Hôtel Dieu where the crowded maternity quarters were located over the unhealthy surgical wards, several patients even confined in one bed. The infants perished in great numbers at the Foundling Hospital, due to the excessive crowding in cold damp dark rooms. In the third volume, Madame Lachapelle discusses eclampsia, puerperal fever, rupture of the uterus and operative obstetrics. In spite of the outstanding work of Labarraque and the rôle of chlorine in combating infection, there is no mention in Madame Lachapelle's work of even a trial of this powerful agent.

The period under discussion practically closes with the work of Madame Marie Anne Victoire Boivin (1773–1847), who was a voluminous writer on the subject of midwifery. Most of her work shows care in both arrangement and treatment of the subject matter. She was in the Maternité in Paris from 1797 to 1811, where she was under such teachers as Madame Lachapelle and Chaussier. The first edition of her work entitled, *Mémorial de l'art accouchements. Ouvrage pratique . . . suivi des aphorismes de Mauriceau*,[1] sets forth her methods which she learned at the Maternité. The second edition was published in 1817, and contains 136 engravings, and six statistical tables of 24,214 births. In speaking of extirpation of the ovary she mentions McDowell's cases, Nathan Smith's case, as well as those of a few others, and says:

> "There are then fifteen cases of this operation, namely extirpation, of which six have been attended with at least temporary success, five with neither good nor bad results, and four with death."

Because of the popularity of this book the jealousy of Madame Lachapelle was aroused, and Madame Boivin was compelled to give up her position at the Maternité. Shortly thereafter she accepted a position as midwife in the hospital of Poissy and the Maison de Santé. In her leisure moments she read many of the English works on obstetrics and gynecology and wrote a monograph on *Hemorrhages of the uterus*, for which she was awarded a prize. With Dugès, a nephew of Lachapelle, she wrote a two-volume work entitled: *Traité pratique des maladies de l'uterus et de ses annexes*, which was published in Paris in 1833, and afterward translated into English by G. O. Heming, consulting obstetrician to the St. Pancras Infirmary. Because of her writings Madame Boivin was given the honorary title of Doctor of Medicine by the University of Marburg.

EARLY GERMAN MIDWIFERY AND THE ADVENT OF CELLULAR PATHOLOGY

Scientific midwifery in Germany was somewhat slower in development than in France and England. Most of the works on surgery published in Germany included midwifery, and we have noted that Lorenz Heister was the first to publish an account of Palfyn's forceps. Midwives, however, were numerous and probably to a greater extent than in France and England held dominion over both physiologic and pathologic parturition. Equally distinguished with French female accoucheurs was Justine Siegemundin, née Diettrichin (b. 1650), the most celebrated of the German midwives of the late seventeenth century. According to her own account she was married at

[1] Paris, 1812.

glycemia is an important factor in the production of true severe, preeclamptic toxemia, and eclampsia. Stander, Eastman, Harrison and Cadden, however, were not able to duplicate these findings, and, on the other hand, their studies would indicate that there is hyperglycemia rather than hypoglycemia in these conditions. Johnston, Johnson, and Nicholas expressed the belief that action of bacteria, possibly colon bacilli on the amino acids, produces poisonous amines, of which tyramine is the most important. When given intravenously tyramine causes peripheral necrosis of the hepatic lobule. Amino acids may be in excess in the blood, due to absorption of a placental infarct, ingestion of a large amount of meat, or restricted elimination.

Broadened physiologic chemical research in the field of medicine during the last ten years finds no more intriguing subject than toxemia of the later months of pregnancy. The relative frequency of these forms of toxemia, the bizarre features incident to convulsions, and the relatively high maternal and the high fetal mortality which still obtains, invite the research worker. In fact, so much chemical research has been done in this field, that it is impossible, in the scope of this chapter, to make more than brief mention of the more plausible hypotheses. The reader is referred to excellent monographs by Stander[121] and Hinselmann on toxemia of pregnancy in which various hypotheses are ably presented.

Prodromal Symptoms.—Ordinarily, eclamptic convulsions are preceded by warning symptoms: Edema, severe and often persistent diffuse headaches, disturbances of vision such as flashes or spots before the eyes, and dimness, and epigastric pain. In many instances the patient is led to consult a physician by one or more of these symptoms, or she may be unaware of their serious significance until the onset of convulsive seizures. Other premonitory symptoms may be nervous irritability, muscular twitching, restlessness, and sleeplessness. Less commonly, unusual drowsiness may precede the attack.

Eclamptic Convulsions.—An eclamptic convulsion presents typical features resembling most nearly an epileptic attack. The onset is usually abrupt, and may occur while the patient is standing, sitting, or lying down. A sharp cry may initiate the seizure and this may be followed by clonic, convulsive jerking of the muscles of the extremities and face, grinding of the teeth, and the appearance of froth, often bloody, on the lips. If the tongue is not protected with padded mouth gags it is very likely to be lacerated between the teeth. The eyes are staring and fixed, usually with dilated pupils. The face is flushed, with veins distended. The clonic movements may last for thirty to sixty seconds, and may be followed by tonic rigidity for a somewhat shorter period. The breathing, which was shallow or absent during the clonic period, becomes deep and stertorous. Usually the patient is more or less cyanosed. Sometimes urine and feces pass involuntarily. The woman may pass into a state of coma lasting a varying length of time, from a few minutes to several hours. The pulse is rapid and full, and there is usually a rise in systolic blood pressure of from 10 to 30 mm., accompanied by a distinct though less marked rise in diastolic pressure. Ordinarily, there is a rise in temperature of 2 to 5 degrees. The temperature may go to 105 F. and Williams cited a case in which the premortem temperature was 109 F. Fever is apparently due to disturbance of the thermal center rather than to infection. In the most favorable case no further convulsions ensue; in other

cases the patient may improve only to have convulsions days or even weeks later, the so-called "recurrent eclampsia." The convulsive seizures may return within a few minutes in the most serious cases, or at varying intervals, sometimes several hours apart. As the convulsions proceed they become more severe, often with shorter intervals between them, more marked cyanosis, rapid pulse, and gradually deepening coma and death. In rare instances death may follow one or several convulsions, although the average in fatal cases may be between ten and twenty.

The number of convulsions is not necessarily an index of the severity of the condition for a case has been reported in which more than 100 convulsions were followed by recovery. Convulsions may occur in pregnancy, in labor, or soon after parturition. The convulsions usually occur in the last month of pregnancy, at or near term; somewhat more than one half occur prior to the onset of labor, about one fourth in labor, and approximately one fifth later. At the New York Lying-in Hospital, Davis and Harrar found that the convulsions occurred in pregnancy in 54 per cent of cases, in labor in 16 per cent, and postpartum in 30 per cent. Greenhill reported from the Chicago Lying-in Hospital percentages of 50, 30, and 20 respectively. Hinselmann, with figures of 26, 53, and 21 per cent respectively, may have included in the intrapartum group those patients whose labor started in the course of the convulsive seizures. Williams' percentages were respectively, 55, 22, and 23.

The muscular irritability and tonicity which accompany eclampsia frequently result in the onset of labor following one or more convulsions. Convulsions occurring in labor serve to hasten delivery by accentuating the frequency and intensity of uterine contractions. These convulsions usually cease after delivery of the child. Rarely do postpartum convulsions occur more than twenty-four hours after completion of labor.

Differential Diagnosis.—Convulsions occurring during pregnancy may be caused by conditions other than eclampsia. Chief among these causes are epilepsy, uremia, apoplexy, and hysteria, but it may be necessary to identify any disease which could cause convulsions in nonpregnant women. A careful history should be taken to determine if the patient has had previous convulsions; the attacks must be observed; physical examination including inspection of the ocular fundi should be given; urinalysis and chemical examination of the blood are indicated. These measures usually serve to rule out those other conditions which might simulate the convulsions and coma of eclampsia.

Prognosis.—In the birth registration area of the United States, comprising 94.7 per cent of the population of continental United States, there were, in 1928, 3821 deaths from "puerperal albuminuria and convulsions," an incidence of 25.9 per cent of the total deaths from puerperal causes. Other countries in temperate climates have a somewhat similar death rate from eclampsia. Mosher quoted Canadian statistics showing that eclampsia caused 22 per cent of the deaths from puerperal causes in 1927. The percentage of deaths from eclamptic convulsions varies according to various observers, and apparently in different countries.

The maternal mortality varies, depending on the geographic locality and the type of care. Reinberger and Schreier reported 42.4 per cent mortality following cesarean section for eclampsia between the years 1916 and 1929, and

Stroganoff reported 2.6 per cent maternal mortality in the conservative treatment of eclampsia. It has been suggested that Stroganoff's low mortality rate may have been due to his encountering a particularly mild type of the disease. Griefenstein reported maternal mortality from eclampsia of 15.5 per cent in 212 cases. Davis and Davis and Harrar reported 23 per cent maternal mortality among 879 cases of eclampsia at the New York Lying-in Hospital over a period of thirty years. The latter reported maternal mortality from this cause of 15 per cent for a period of eight years, ending in 1926. Greenhill reported a maternal mortality of 10.3 per cent for prepartum, 0 per cent for intrapartum, and 8.7 per cent for postpartum eclampsia. The highest death rate is in prepartum eclampsia, especially in primigravidas. Death in convulsions may result from cardiac failure, pulmonary

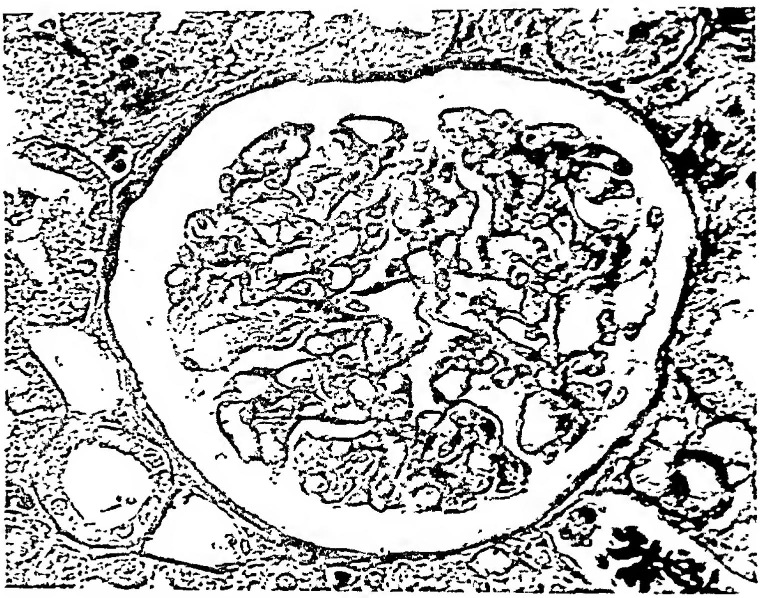

Fig. 494.—Renal glomerulus in a case of eclampsia (× 430), partially obstructed capillary loops (due chiefly to increase in number and swelling of capillary endothelial cells); thickening of glomerular basement membrane, and a relatively larger size of glomerulus in relation to capsule than normal may be noted.

edema, and cerebral vascular injury. Most of those patients who recover from convulsions will live, although death may occur later from aspiration pneumonia or sepsis, for these patients resist infection poorly.

The infant death rate is higher than that of the mothers, ranging from 24 to 40 per cent. Many fetuses die undelivered, others die from prematurity, toxemia, injuries at birth or possibly as a result of drugs used to control the mothers' convulsions.

Pathology.—The pathologic lesions of eclampsia are chiefly those of the liver, kidneys, brain, lungs, and heart. Fahr[25] has agreed with Schmorl that thrombosis and emboli of parenchymatous cells may occur in all organs; yet he has expressed the thought that these changes are results of and not the cause of eclampsia (Figs. 494–499).

Ewing, Williams, Opie, Allen, and others have considered the hepatic lesions to be characteristic of the disease. These are described as throm-

Fig. 495.—Normal renal glomerulus (Mallory-Heidenhain stain) (× 430).

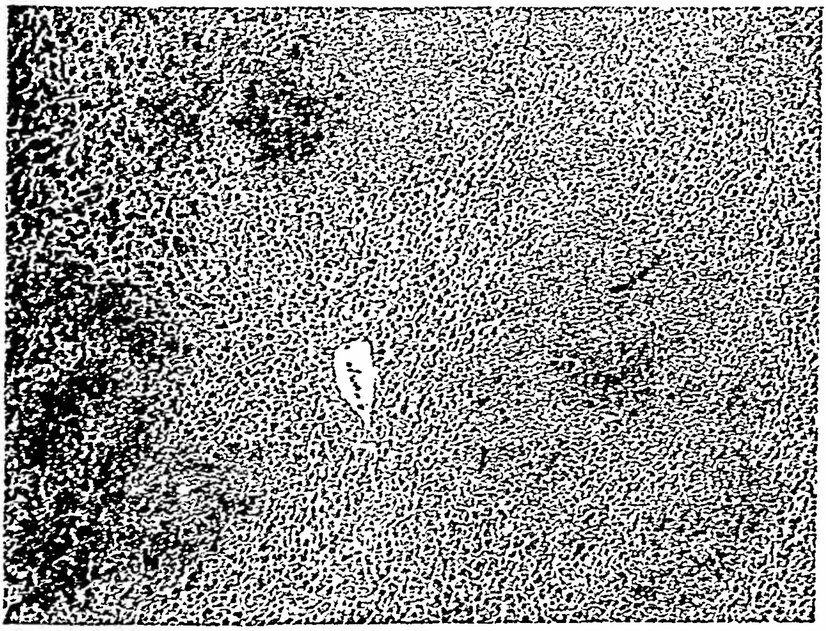

Fig. 496.—Liver from eclamptic patient; periportal lesion with necrosis of liver cells may be seen (× 60).

bosis of the smaller interlobular periportal vessels, with hemorrhagic and anemic necrosis, and occasionally diffuse thrombosis of the portal vessels, with degenerative changes in the parenchyma. Robertson is of the opinion

that this is a hyaline thrombosis of the sinusoidal vessels, with necrosis of the hepatic cells, and that erythrocytes are not evidence of hemorrhage unless

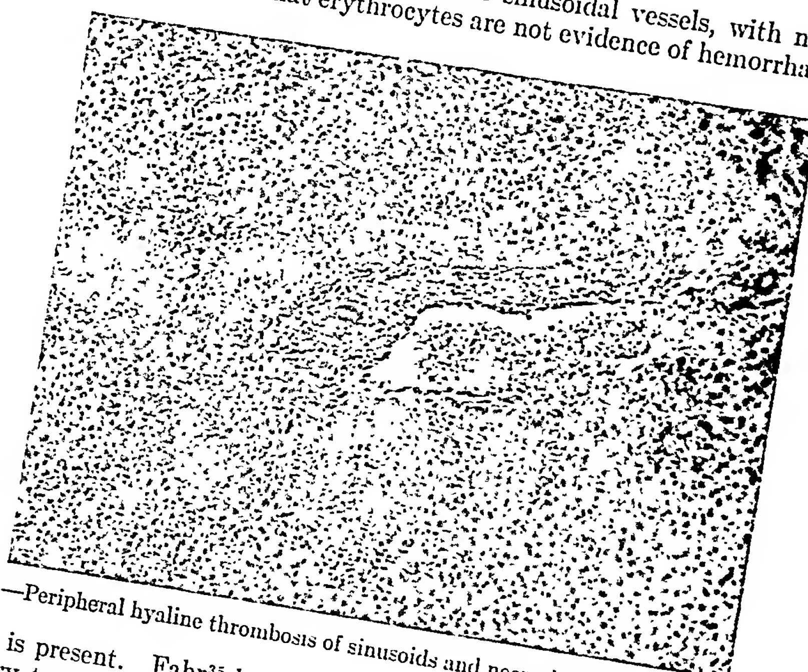

Fig. 497.—Peripheral hyaline thrombosis of sinusoids and necrosis of hepatic cells (× 110).

clotting is present. Fahr[35] has suggested that the degenerative changes are secondary to circulatory changes, but that the most characteristic changes

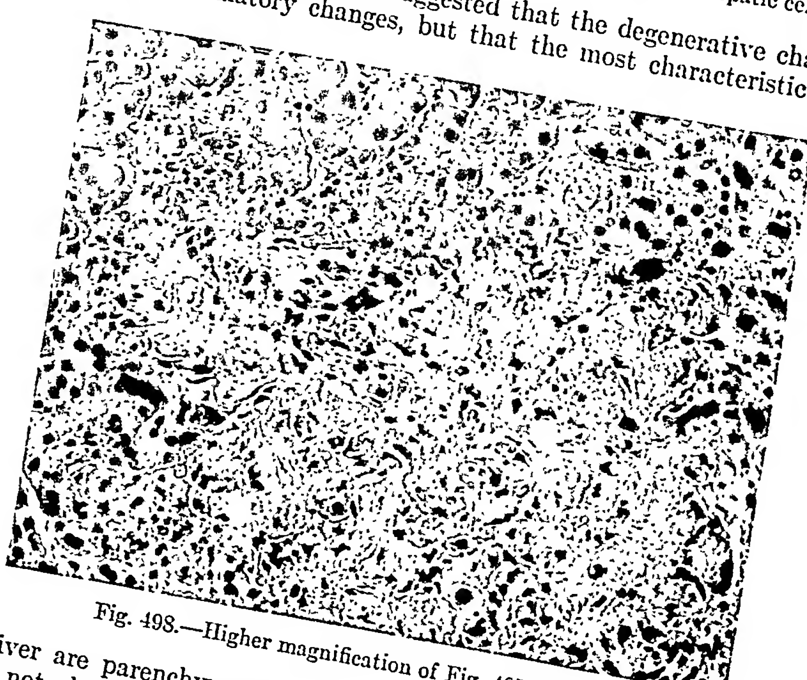

Fig. 498.—Higher magnification of Fig. 497 (× 225).

in the liver are parenchymatous degeneration affecting regions of varying size and not always recognizable macroscopically unless several lobules are

involved, then the changes appear in punctate, slightly depressed, irregular spots. This necrosis is more often found in the periphery of the lobules, close to the periportal spaces, than elsewhere. On the other hand, Bell and Leusden have expressed the belief that the hepatic lesions are not always typical. Fahr[35] did not find that degree of the hepatic injury corresponded with the frequency or severity of convulsions. In some cases there were no definite changes in the liver.

Bell noted that Prutz, in 1897, in postmortem examination of 138 victims of eclampsia found normal kidneys in only 7 cases. Fahr[36] has expressed the thought that the glomerular lesion is peculiar to eclampsia. Fahr, Schwarz and Dorsett and Lubarsch have viewed the renal lesion as a form of glomerulonephrosis, and not as an inflammatory condition such as is seen in glomerulonephritis of infectious origin. The glomerular capillaries are widened, have distorted and sometimes adherent loops, with poor cellular outlines

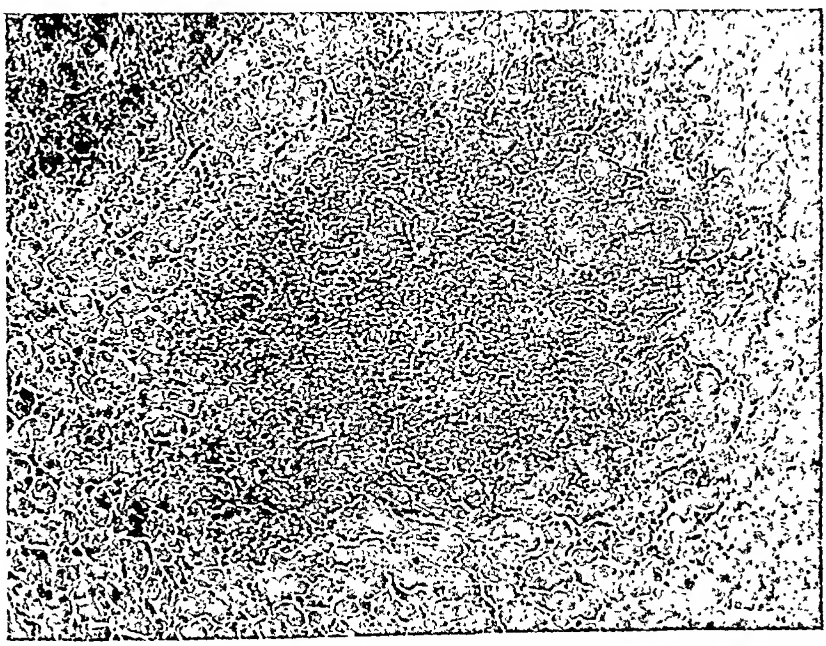

Fig. 499.—Parenchymatous necrosis (peripheral) with extravasation of blood into necrotic zone (× 125).

and few nuclei. Although not all glomeruli are affected, there are degenerative changes in the tubules resembling the changes of lipoid nephrosis. Bell, in a recent article on the renal lesions of toxemia of pregnancy, agreed in general with Fahr, Schwarz and Dorsett and Fahr.[35] He pointed out, however, that the azo-carmine stain brings out remarkably the detailed structure of the glomerulus. This has enabled him to identify a glomerular lesion characteristic of these forms of toxemia; the glomeruli are slightly enlarged, and the lumens of their capillaries are narrowed and sometimes completely closed; the decrease in the size of the lumen is caused chiefly by marked thickening of the capillary basement membrane. Occasionally there is marked increase in endothelial cells and then there is a definite resemblance to the appearance in acute glomerulonephritis. Cruickshank described symmetrical necrosis of the renal cortex, which might occur as one of the manifestations of eclampsia.

In many instances edema of the brain is found with at times anemia. At other times, hyperemia without edema is present and also areas of thrombosis, capillary hemorrhages and at times larger hemorrhages are seen.

Lungs often are normal. Sometimes there is edema or pneumonia at the bases, with the same thrombotic process as in the liver. In 1895 Leusden reported that frequently giant cells composed of masses of syncytium are found in the pulmonary capillaries. Degenerative changes appear in the heart muscle, varying from cloudy swelling to fatty change; some thrombosis occurs. Polak, and Polak and Beres found degenerative changes in the heart in 94 of 102 postmortem examinations.

General Consideration of Treatment.—Eclamptic convulsions present an emergency requiring immediate treatment. It is obviously necessary to control convulsions, whether they occur before, in the course of, or after, the birth of the child. A majority of the convulsions occurring before labor or in labor cease when the uterus is emptied, and this has led to the employment of so-called "radical methods" for the immediate termination of pregnancy, rather than conservative measures.

Conservative treatment in its strictest sense deals with measures for control of convulsions; delivery of the patient is not forced, although measures may be used to shorten the second stage of labor.

Modified conservative treatment or "middle line" treatment employs measures to control convulsions or to prevent impending convulsions. These are induction of labor in some instances following control of convulsions; employment of measures to shorten the second stage of labor; delivery by cesarean section in certain cases when convulsions have been controlled, or when attempts to control convulsions have failed, or in some cases of impending eclampsia.

Radical treatment consists in immediate emptying of the uterus by abdominal cesarean section in each case in which convulsions appear if the patient is not in labor, and in some instances during the first stage of labor; or by shortening the progress of the first stage of labor by forcible dilatation of the cervix and delivery by version or forceps extraction.

In the sixteenth century, Paré advised accouchement forcé, the immediate and more or less forcible dilatation of the cervix and delivery of the fetus, as a means of controlling the convulsions and the progress of the disease. Although in the nineteenth century other measures, such as application of hot packs, venesection, administration of chloroform, of morphine, and of chloral were advocated for control of the convulsions, various radical measures were almost universally employed for this purpose until the conservative method used and advised by Stroganoff was made known in 1909. Since then, many obstetricians have used the Stroganoff method with various modifications. In the hands of Stroganoff and many others the maternal death rate in eclampsia has fallen from a percentage of 20 and more to a percentage of 10 and less. Stroganoff stated his maternal death rate from eclampsia in 1923 was 9.3 per cent, and, as has been said, in 1928, 2.6 per cent. Reporting all cases of eclampsia observed in the clinics of Vienna in the last seven years, Hermann, in 1930, found a maternal mortality of 4 per cent among 101 cases in which treatment was by conservative methods, and of 10 per cent among 449 cases in which treatment was of the "middle type." On the other hand, favorable reports have been made by some

who have advised immediate delivery by abdominal cesarean section in cases of eclampsia. Waldestein reported a maternal mortality of 1.7 per cent in 33 cases; Fürst, nine deaths in 238 cases. Johnston and Johnson, employing cesarean section under spinal anesthesia, reported 25 cases with no maternal deaths and only one fetal death. Reinberger and Schreier, however, in 1929, reported 33 cesarean sections with fourteen deaths, a mortality rate of 42.4 per cent; their maternal mortality with conservative measures was 28 per cent and the fetal mortality 31.7 per cent.

In a review of deaths following eclampsia, Plass found among 4607 cases in which treatment was by active intervention, between 1911 and 1926, that there were 997 maternal deaths, a rate of 21.7 per cent, whereas among 5976 cases in which treatment was conservative, between 1916 and 1926, there were 665 deaths, a maternal death rate of 11.1 per cent. Greenhill, in 1926, reported the outcome of treatment of 78 patients with eclampsia at the Chicago Lying-in Hospital. The maternal death rate, including one patient who was moribund on admission, was 7.7 per cent. The fetal mortality was 27.7 per cent. Greenhill stated that the treatment was neither radical nor conservative, each case being individualized; fifteen abdominal cesarean sections were performed. Gyllensvärd reported from the Stockholm-Süd Maternity Hospital on cases seen from 1911 to 1928; there was a maternal mortality of 7.8 per cent and a fetal mortality of 31 per cent among 282 women with eclampsia who were treated chiefly by conservative measures.

The trend in the treatment of eclampsia in the last ten years, especially in this country, has been toward modified conservative, "middle line" methods, although operative delivery, chiefly abdominal cesarean section in selected cases, has been used more freely in recent years.

Stroganoff's treatment is based primarily on relief of convulsions by sedative measures. For this purpose he recommended morphine and chloral. The patient immediately is given morphine, $\frac{1}{4}$ grain hypodermically; one hour later, 20 to 40 grains (0.016 Gm.) of chloral by rectum; two hours later, the same dose of morphine is repeated. This is followed at intervals of four, six, and seven hours by administration of chloral by rectum in doses of 15 to 30 grains (1 to 2 Gm.). Following a small cleansing enema the chloral is dissolved in 150 cc. of warm water and injected slowly into the rectum. Stroganoff advised a dark quiet room, and the employment of chloroform to control convulsions. Under this regimen he found that some patients had no more convulsions and that pregnancy proceeded to full gestation and labor; in others, convulsions ceased for hours or days only to recur; still others went into labor spontaneously during the convulsion or following control of convulsions. For some patients whose convulsions were not satisfactorily controlled, he advised induction of labor.

Although several European clinics have followed closely Stroganoff's method none has been able to report such low maternal mortality as he. Adopting the principle of controlling convulsions by sedative measures the majority of obstetricians in this country are attempting to control the convulsions before resorting to operative measures for termination of pregnancy.

Usually convulsions cease following measures similar to those advised by Stroganoff. After the cessation of convulsions or in the course of eclampsia, various additional measures for reducing hypertension and other manifestations of toxemia have been advised. Elimination is of value, and gastric

lavage has been employed; this is followed by ingestion of 2 fluidounces (60 cc.) of castor oil, or of magnesium sulphate in solution. In the "Rotunda method" Tweedy advised starvation, catharsis, and flushing the colon with copious enemas of hot water. Venesection, freely employed during the nineteenth century, is now used less commonly. It reduces blood pressure temporarily and is said to be of value when the hypertension is accompanied by a diastolic pressure of 120 mm. or more.

Titus, McConnell, and others have advised intravenous infusion of 75 to 100 Gm. of glucose in 5, 10, or 20 per cent solutions. Glucose solution commonly used for the treatment of severe preeclamptic toxemia and eclampsia owes its widespread use to the following apparent actions: Diuretic; sparing of the liver or possibly actual regeneration of the liver; reduction of acidosis, and decrease of cerebral and general edema following use of the more concentrated solutions.

Following the procedure that Thalheimer used in the treatment of hyperemesis, Stander, and Duncan advised hypodermic injection of 1 unit of insulin for each 3 Gm. of glucose, up to 15 or 25 units, for patients who were in coma or semiconscious following a convulsion, whose carbon dioxide combining power was 30 volumes per cent or less and whose value for blood sugar was elevated. Miller reported the use of 1 unit of insulin for each 3 Gm. of glucose until 10 or 15 units had been given, on the hypothesis that the insulin renders the glucose more effective. Titus took issue with the use of insulin in eclampsia, for he believed that eclampsia and hypoglycemia from insulin were extraordinarily alike.

The use of solution of magnesium sulphate has been found valuable, partly because of its sedative action and partly because it reduces edema of the brain and other tissues and produces diuresis. Twenty cc. of a 10 per cent solution may be given intravenously. Lazard and McNeile and Vruwink reported giving as many as eight of these intravenous injections of magnesium sulphate in twenty-four hours, but Stander[122] warned against using more than six, and Keith's belief is that its use intravenously is dangerous. Dorsett reported good results following the use of magnesium sulphate in doses of 15 cc. of a 25 per cent solution injected intramuscularly into the buttock. Schwarz and Dorsett and Dieckmann have reported that they give this dose when the patient is admitted, and give 5 cc. following each convulsion, unless the patient is in coma. They also have advised the use of solutions of dextrose intravenously, in addition to magnesium sulphate.

Miller and Martinez reported a maternal mortality of 6.9 per cent among 43 patients with eclampsia who were treated with intramuscular injections of a liver extract, which is said to aid the diseased liver. Mendenhall and Smith, using a similar extract, treated 25 patients with late toxemia of pregnancy, and obtained a beneficial result in only 1 case. Irving and Taylor reported that from 14 patients with convulsive toxemia blood was withdrawn, the plasma removed by centrifugation, and the corpuscles reinfused; some patients improved and no harmful effects were noted.

It is of value in the treatment of eclamptic convulsions to have a routine of sufficient elasticity to meet such indications as may arise in the individual case. Eclampsia is cared for much more easily and safely in well-equipped and conducted hospitals, but even when only fair hospital facilities are available the patient with eclamptic convulsions should be hospitalized

immediately if possible. In many instances, the first convulsion occurs at the patient's home and the physician who is called should give the patient morphine, $\frac{1}{4}$ grain (0.016 Gm.) or even $\frac{1}{2}$ (0.032 Gm.) hypodermically, if any delay is encountered before the patient enters the hospital. If it is necessary to continue treatment in the home, many of the measures advised under conservative treatment may be used.

Authors' Procedure.—The treatment of eclampsia may be grouped under four headings: Control of the convulsions; amelioration or relief of hypertension and other symptoms of the toxemia; termination of pregnancy, and postpartum care.

On admission to the hospital, sedative measures are instituted immediately following inquiry as to what and how much sedative has been given the patient prior to admission. If none has been given, morphine, $\frac{1}{4}$ grain (0.016 Gm.) in 2 cc. of 25 per cent magnesium sulphate solution, should be administered intramuscularly. The same dose may be repeated in an hour or less if convulsions continue or impend. Care is taken to record the respirations, which should not be retarded to less than ten each minute by the morphine. Chloral hydrate may be used as advised by Stroganoff. The introduction of derivatives of barbituric acid has provided another valuable group of sedatives. Waldstein has used phenobarbital in the treatment of eclampsia and Moore reported the use of sodium iso-amylethyl barbiturate (sodium amytal) in 4 cases of severe preeclamptic toxemia. In addition to morphine we have used sodium iso-amylethyl barbiturate, 6 grains (0.4 Gm.), and later pentobarbital sodium, 6 grains (0.4 Gm.), intravenously in eclampsia and in threatened eclampsia with excellent sedative effect. The drug is given slowly and the patient falls asleep while it is being administered. Moderate shock, noted by Moore in two of his cases, has not been evident. When the diastolic blood pressure is more than 120 mm. and convulsions impend, or when there is cyanosis, 300 to 500 cc. of blood may be withdrawn by venesection. Sufficient of this is used for necessary chemical examinations. The blood is examined for the carbon dioxide combining power, and the values for nonprotein nitrogen, sugar, and chlorides are determined. If venesection is not made, at least enough blood is withdrawn for chemical analysis. Usually venesection temporarily lowers the blood pressure, probably relieves congestion and stasis of the cerebral and glomerular vessels, and indirectly increases output of urine. In the event that there is no spontaneous urination, the patient is catheterized to determine whether there is anuria, and to obtain a specimen for urinalysis. Examination of the ocular fundi is made at the first opportunity, although this is impossible while the patient is in convulsions and may be made difficult by pupillary contraction due to morphine. Whether or not venesection is done, the patient is given 500 cc. of 20 per cent solution of dextrose intravenously. This is given slowly over a period of thirty to forty-five minutes, and the injection may be repeated in four or more hours. Injection of the 20 per cent solution of dextrose in amounts not more than 500 cc. may be repeated several times, but if the patient is not edematous, or after the output of urine has increased, the concentration of the solution of dextrose is reduced to 10 per cent, the diluent being 0.6 to 1 per cent solution of sodium chloride. Large quantities of solutions must be used with care intravenously, for they may disturb the physiologic-chemical balance. If the solutions are given too rapidly, pulmonary edema

Not until 1814 was a professorship in obstetrics established at Vienna with **Lucas Johann Boër** (1735–1855) as the first occupant of the chair. Boër was essentially English trained, although he had studied in both France and Italy, having been especially delegated to search out new developments in obstetrics by Emperor Joseph II (1741–1790) of Austria. He was originally a pupil of Caspar von Siebold at Würzburg and thus early received the stimulus of the Leyden school. In London, Boër attended the lectures and clinics of the best teachers in midwifery, particularly Thomas Denman, William Osborn, and John Leake. He returned to Vienna in 1788, at which time he was appointed to the surgical staff. He discarded the labor stool (Fig. 45) and was insistent upon reliance upon the forces of nature. Fas-

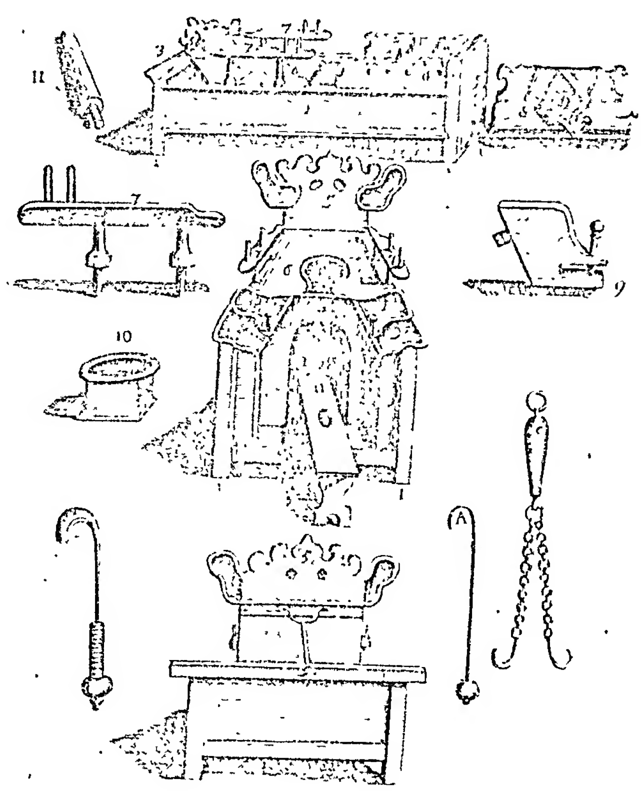

Fig. 45.—Engraved plate showing lying-in room furniture in use in the sixteenth and seventeenth centuries. The use of this equipment was discontinued in most quarters early in the eighteenth century. From *Die Chur-Brandenburgische Hoff-Wehe-Mutter* by Justine Siegemundin, Cölln. a. d. Spree, 1690.

bender says[1] that Boër learned the art of obstetrics in France, and in England he learned to rely upon the forces of nature. He is regarded as the father of German obstetrics. **Johann Georg Röderer** (1726–1763), another German obstetrician, had received his training in Paris and in London. Röderer founded a lying-in hospital at Göttingen in 1751. Following the English and French example numerous other lying-in hospitals were founded in Germany in the latter part of the eighteenth and early in the nineteenth centuries. Quite in contrast with the teachings of Boër, **Friederich Benjamin Osiander** (1759–

[1] Loc. cit.

rises upward into the abdomen and continues in an anteverted position. When this anteversion becomes exaggerated, as occasionally occurs in a pendulous abdomen, a condition arises which frequently provokes a great deal of discomfort and may produce dystocia.

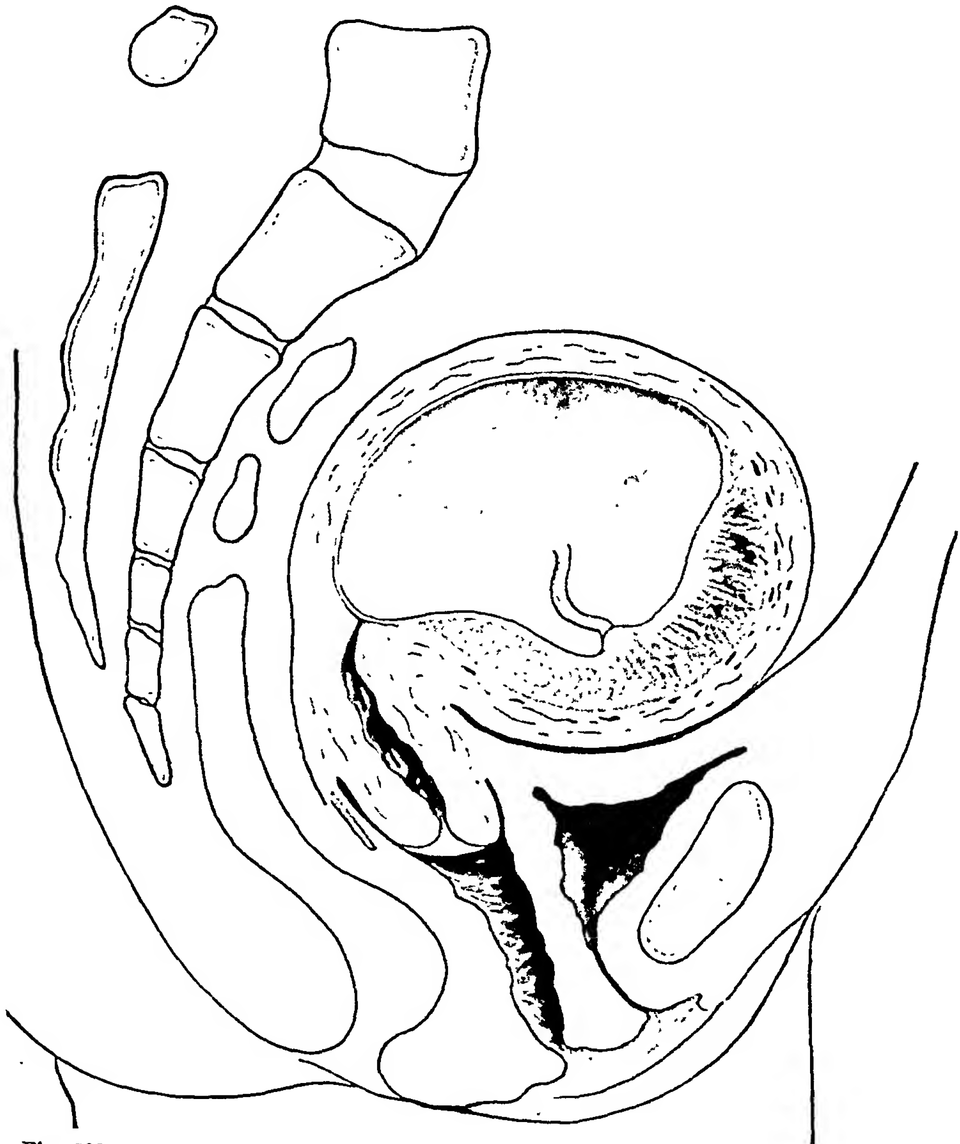

Fig. 500.—Normal position of uterus at end of third month of pregnancy. (DeLee, "Principles of Obstetrics.")

The harmful effects upon pregnancy of the various malpositions of the uterus are due to their influence upon impregnation, to the possibility of the interruption of pregnancy, and to the difficulties which they may produce during labor and the puerperium.

Retroversion and retroflexion occur in at least 25 per cent of all women and are by far the most common type of displacement. This frequency emphasizes their great importance in pregnancy. In the majority of instances the displacement antedates the pregnancy.

In general, it should be emphasized that in the ordinary uncomplicated case of uterine retrodisplacement fertility is not impaired, pregnancy may go on without interruption, labor may proceed normally, and a normal puerperium may follow.

However, if the uterus is displaced posteriorly and is incarcerated below the promontory by adhesions or pelvic tumors or from any other cause, the effect upon the pregnancy may be disastrous. DeLee classifies the results which may occur after displacement as follows:

1. Spontaneous rectification.
2. Abortion.
3. Partial restitution.
4. Incarceration.

Spontaneous restitution usually occurs about the third month of pregnancy. All experienced obstetricians have observed the peculiar ability which the pregnant uterus possesses, to adjust itself into abnormal position, and how it elongates and widens before abortion occurs. In many instances the uterus will overcome all obstacles and the pregnancy will terminate normally.

Some authorities state that, when a retroversion is marked, spontaneous restitution is almost impossible, for the reason that the cervix rises above the symphysis pubis while the fundus is held back by the promontory of the sacrum; and that abortion usually occurs during the third month, when the pelvis is filled and the uterus becomes irritated by pressure.

At the present time the author has under observation an extremely neurotic young woman just beyond the second month of her pregnancy. When conception occurred the uterus was markedly retroverted and deviated to the left to an extreme degree (Fig. 501). Management has consisted of rest in bed on the right side, the knee-chest position night and morning, and lying face downward for an hour twice a day. The uterus is gradually approaching the median line and gradually rising out of the pelvis; although sharp bleeding and pain and other symptoms of threatened abortion have arisen, a favorable outcome is anticipated.

Abortion usually occurs if the uterus must have more room and is unable of itself to assume a normal position, unless the obstetrician aids nature's attempt at replacement by manual replacement and pessary support until the uterus rises out of the pelvis. It is not always possible to state why abortion occurs in these cases, but it is usually ascribed to circulatory changes which occur as the result of pressure and tension due to adhesions.

There are cases in which partial restitution occurs; a part of the fundus remains in the pelvis while the anterior portion enlarges and extends into the abdomen. Such cases may go on to full term because of adaptation of the uterus to its environment but, in the majority, abortion or premature labor occurs.

An incarcerated pregnant uterus offers very little hope for continuation of the pregnancy and serious complications may result. The first symptoms of which the patient complains may be dysuria or inability to control the

urine. The obstetrician should suspect a posterior displacement when these occur. In this connection, it is well to remember that early in pregnancy posterior displacement of the uterus may be easily mistaken for ectopic pregnancy or some other pelvic lesion.

The treatment of malpositions of the uterus during pregnancy presents a considerable responsibility. The obstetrician must individualize in the management of each case. Inasmuch as most retrodisplaced pregnant uteri undergo spontaneous restitution, such cases usually require only careful observation of the patient, who should be made to understand the value of proper rest, a cardinal consideration. In the writer's experience it has rarely been necessary to resort to the use of a pessary if the patient can be made to understand the necessity of rest, the avoidance of trauma, *e. g.*, sexual

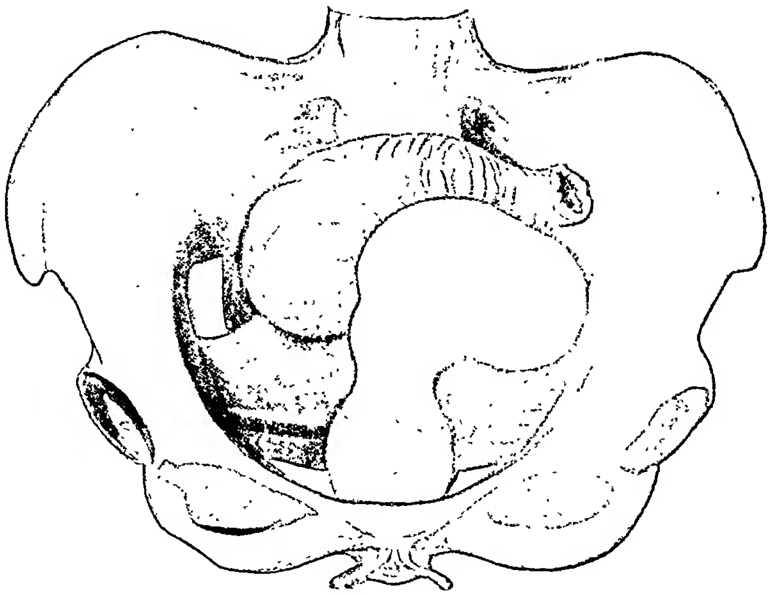

Fig. 501.—Lateral deviation of retroverted pregnant uterus. (Author's case.)

abstinence, and if she makes use of the above-described postural treatment until the third or fourth month.

If conservative treatment fails it may be necessary to introduce a pessary. When this is resorted to it is important to exercise the greatest gentleness because of the danger of producing abortion. The best method of introducing the pessary is to place the patient in the knee-chest position and make gentle traction on the cervix while the uterus is carefully pushed upward and the pessary inserted. Regular and frequent attention must be given to the bladder and rectum in all cases in which a pessary is employed. Manual replacement alone will sometimes produce a satisfactory reduction. See Chapter LXV, Retrodisplacements of the Uterus.

Danforth and Galloway, in reviewing 1000 cases of retrodisplacement of the uterus during pregnancy and the puerperium, accentuate the value of

proper puerperal care, and in common with most obstetrical specialists advise that the patient be placed on her face, for ten minutes, once or twice a day or oftener, to aid involution and to prevent retrodisplacement. They also advise introduction of the pessary six weeks postpartum, and further state that manual reposition is required in about 30 per cent of all retrodisplacements of pregnant uteri. In the author's experience it has not been found necessary to resort to manual reposition nearly so frequently as have Danforth and Galloway.

Procidentia produces much discomfort during the first few months of pregnancy. While it usually results from parturitional injury, one occasionally sees cases of congenital origin. It is usually associated with inversion of the vaginal wall; the anterior wall usually evaginates first. This condition sometimes makes the early diagnosis of pregnancy very difficult. Pregnancy rarely continues more than three or four months before abortion occurs. However, if the pregnancy continues long enough for the uterus to rise into the abdomen the cervix usually will ascend with it, and it may thereafter continue normally. Couvreux mentions complications which occur unless restitution can be made, such as soft edema of the prolapsed part, and ulceration of the cervix and cervical endometrium. Abortion and premature labor are common occurrences, while protracted labor, rigidity of the cervix and dystocia may complicate this condition.

Prolapse of the uterus during pregnancy should be managed by an endeavor to replace the uterus and hold it in position by perineal support or rest in bed. According to Couvreux and other observers, these cases, if they go to full term, usually have longer labor but may not require intervention. The cervix is usually elongated and rigid and thick. Couvreux suggests that an attempt be made to control expulsive efforts before dilatation is complete. It may sometimes be necessary to use the dilating bag or to resort to cesarean section. Following each delivery the prolapse is usually worse, the cervix more elongated and more hypertrophied.

If the patient does not appear for prenatal care until the pregnancy is advanced so far that the uterus is irreplaceable abortion may be indicated.

There is a rare form of malposition of the uterus known as axial rotation. Feiner and Kaldor state that the nonpregnant uterus of normal size and shape cannot turn around its long axis beyond a physiologic degree but that this does not hold true for the tumorous and pregnant uterus. Küstner, quoted by these authors, believes that abnormal torsion of the uterus in early pregnancy is not exceptional, and that it either corrects itself as the organ grows out of the pelvis or induces abortion, just as does an incarcerated retrodisplaced uterus. He distinguishes between the twist of the pregnant uterus in early gestation, which he calls torsion, and that very rare condition which may occur in the latter half of pregnancy which he calls "axial rotation of the uterus." Feiner and Kaldor state that the rotation is sometimes 180 degrees or more. They found 10 cases reported in the literature, to which they added the eleventh case. Litten collected 11 cases from the literature and reports his own case, in which the fundus extended 130 degrees to the left of the median line. The patient had a spontaneous delivery with uneventful recovery. Wiegels reports a case of an early pregnancy in which the patient had sharp pains in the left lower quadrant Abdominal operation

revealed a uterus with a 90-degree torsion. This patient aborted on the fifth day. The clinical picture was suggestive of ectopic pregnancy.

In Feiner and Kaldor's case the woman went into labor and after an unsuccessful test of labor the abdomen was opened and the uterus was found rotated 160 degrees from right to left. It was impossible to return it to its normal position without emptying. After emptying, the uterus was restored to its normal position.

There is another type of malposition which results from the operative procedure employed for the cure of malposition. We refer particularly to the interposition operation which was developed by Watkins and Wertheim. This operation, which is done for uterine prolapse, nearly always carries with it serious complications if the patient becomes pregnant. Wertheim advised that every woman of child-bearing age, when submitted to this operation, should be curetted beforehand and sterilized at the time of operation. Notwithstanding the fact that every operator knows that pregnancy following this procedure is dangerous, still occasionally, as the result of forgetfulness or neglect, a patient is either pregnant at the time of operation or is not sterilized during the gynoplasty. A few cases have been reported in which women have gone to full term and cesarean section has been performed, the opening being made in the posterior wall of the uterus. Weibel reports 3 patients who arrived at full-term pregnancy following the operation. One child died after perforation and extraction of the fetus. There was 1 case of cesarean section with a living child. The third case was a full-term pregnancy in which the patient was in labor for eight days, in which perforation and subsequent operation for sterilization were performed. During the interposition operation, according to Weibel, *ligation of the tubes is not sufficient*, but careful resection must be done, including the cornua, if future pregnancies are to be prevented.

Summary.—Malpositions of the uterus frequently accompany and sometimes complicate pregnancy.

The most common displacement is retroversion, which, if uncomplicated, usually produces a negligible effect upon the pregnancy.

Rest in bed, with attention to proper posture, usually results in restitution of the pregnant uterus to a normal position.

If the pregnancy is in an incarcerated retroverted uterus, when the adhesions are sufficiently dense, or when the uterus is imprisoned in the pelvis from other causes, abortion nearly always occurs during the first trimester.

There is a small percentage of retroverted pregnant uteri in which manual replacement or the introduction of a pessary is necessary to effect restitution.

Uterine prolapse, axial rotation, torsion, and displacements due to the interposition operation are complications of pregnancy which may have serious consequences.

CONGENITAL ANOMALIES

The literature on congenital anomalies of the female genitalia, as related to pregnancy, consists chiefly of isolated case reports, of which there are a large number. Few obstetricians have had enough personal experience to establish authentic criteria.

Kossmaul, quoted by Waegner, is credited with establishing the fact that all congenital anomalies of the genital tract are due to arrest of development or malformation in fetal life. Kossmaul classified these arrests of develop-

ment according to the period of embryonic life in which they occur, and states that one of the most frequent anomalies is double uterus, with its variations.

The present discussion is concerned only with a consideration of abnormalities of the female genitalia, per se. Except for the obvious condition of aplasia of the entire genital tract, the author knows of no clinical data which can lead one to suspect aplasia of the ovaries. Various degrees of hypoplasia can be suspected when signs of infantilism are encountered.

Falls states that these anomalies occur in about 1 per cent of pregnancies.

There may be all degrees of arrested development and even a complete absence of the uterus may occur.

The degree of duplicity of the uterus and vagina depends upon the degree of failure of fusion of the müllerian ducts. When the wall between the two

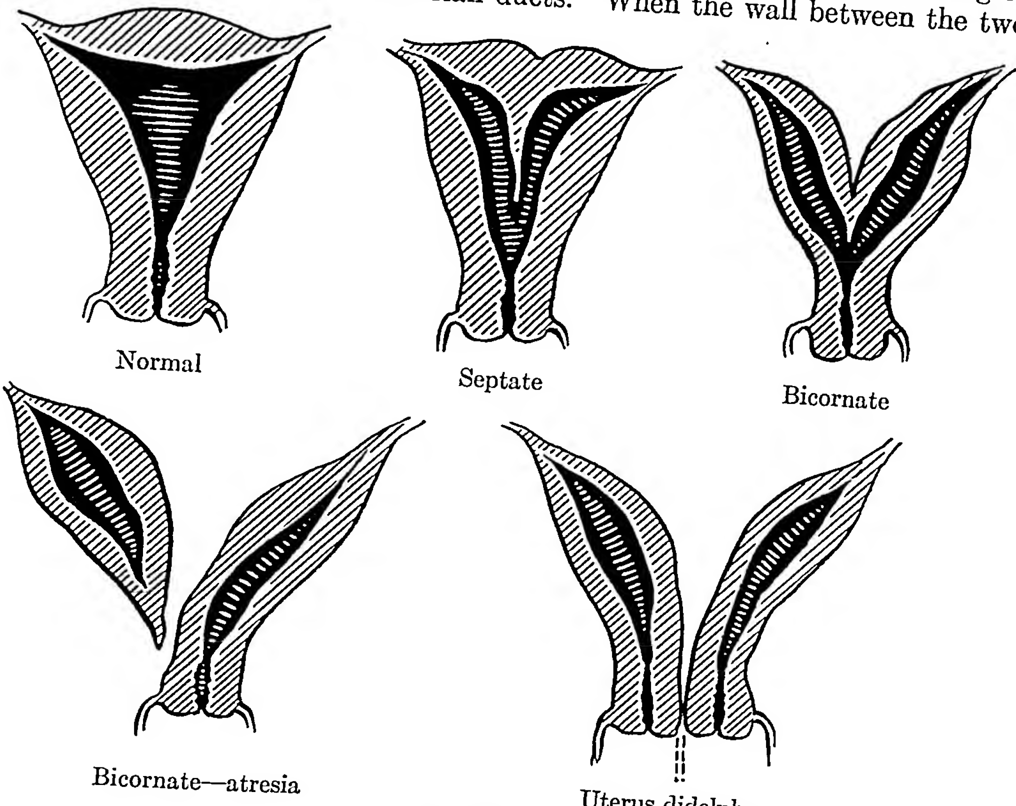

Fig. 502.

ducts remains completely intact there results a double uterus, double cervix, and double vagina known as uterus didelphys. When there is an arrest of development of the uterine portion of one duct the condition is called uterus unicornis. There are other forms of arrested development and all are due to the different degrees of müllerian duct fusion.

Eck states that all the important facts of malformation are not known, and that they are due to germinal defects and to disturbances of canalization. He divides the condition into two large groups: First, lack of fusion of the müllerian ducts without constitutional or germinal defects; second, lack of fusion of the ducts, with one or the other of the above abnormalities. Eck believes that this condition is most frequently found in the broadly built woman of stable temperament.

This condition has been frequently overlooked or neglected but, undoubtedly, when uterosalpingography becomes more of a routine procedure than it has been, many more cases will be discovered.

There is sufficient evidence, however, at the present time, to demonstrate conclusively that these congenital anomalies may have a very serious effect upon pregnancy, and it is the duty of every obstetrician to use every measure at his command to detect any abnormality; for in each instance in which it exists there are possibilities of serious maternal and fetal consequences.

It may be generally stated that genital anomalies have a negligible effect upon fertility. When there is a functioning ovary and a permeable fallopian tube which connects with even a rudimentary uterus, it is usually possible for fertilization and nidation to occur. Furthermore, the developing fetus has a marked power of adaptability to its environment.

Fig. 503.—Uterus didelphys. Lipiodol visualization. (Author's case.)

Palmer Findley believes that some women possess an unusual fertility in cases of uterus didelphys, and states that these women may menstruate during pregnancy.

Pregnancy may occur simultaneously in the horns of a uterus didelphys, or one pregnancy may precede the other, by a few weeks or months. Pregnancy may alternate in the horns of a double uterus; pregnancy may also occur where there is an atresia in some part of the cervix or vagina. The phenomenon of superfetation may find a plausible explanation in this anomaly.

Van de Velde reports a case of congenital atresia of cervix (with impossibility of delivery) in a well-developed pregnant half of a duplex uterus. He also reports a case of pregnancy in a uterus didelphys semi-atriticus, and states that he believes that impregnation took place by the spermatozoa

passing through the normal side of the genital tract out into the abdominal cavity followed by fertilization of the ovum on the stenosed side.

There is some disagreement concerning the influence of these congenital anomalies on the course of pregnancy and labor. It is the author's opinion that any variation from the normal carries with it a certain risk, to both mother and child.

These congenital anomalies are of very much more frequent occurrence than has been believed, and undoubtedly not an inconsiderable number of them produce abortions, miscarriages, and premature labors, also occasional uterine rupture in cases where the causes have been unrecognized, or where they have been erroneously ascribed to other conditions.

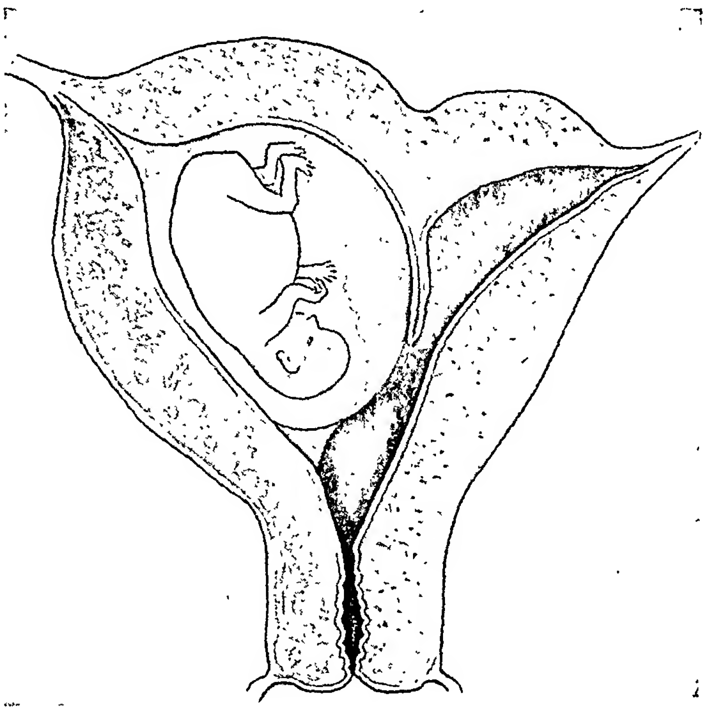

Fig. 504.—Pregnancy in one side of septate uterus. (Author's case.)

Recently the author had a case in point (Fig. 504), that of a woman, age thirty-nine years, who had had five abortions without being able to ascertain the cause; she came for advice in the sixth week of her sixth pregnancy. Because of her age, and because of her indifferent state of health and nervous instability, we advised a termination of the pregnancy by abdominal hysterotomy, to be followed by sterilization. Upon opening the abdomen and mobilizing the uterus, we observed that the right third of the fundus was unusually prominent, and that there was a slight depression, or notch, between it and the other two thirds of the fundus. On opening the uterus over the prominence we removed an intact six weeks' ovum, and upon digital exploration we discovered a septum which divided the uterine cavity into two unequal parts, the part containing the ovum being much larger, probably as the result of physiologic hypertrophy. There was an opening below the septum sufficiently large to admit the finger and to permit a thorough exploration of the other side of the uterus, which

we suspected might also be pregnant. This case illustrates important facts concerning this anomaly, facts which apply equally well in other congenital anomalies: First, with this history this condition should have been suspected; second, this condition might have been diagnosed by hysterography; and third, a metroplastic operation might have been performed earlier in the patient's life so that she could have carried her pregnancies to a successful termination.

Norman Miller states that spontaneous deliveries occur at term in only about 40 per cent of pregnancies with uterus didelphys as a complication and that abortions and premature deliveries occur frequently.

There are a number of cases of spontaneous rupture recorded in the literature. The rupture takes place usually at a later stage of pregnancy than occurs in ectopic gestation.

Epstein and Goldberg think that these anomalies predispose to uterine inertia, postpartum hemorrhage, and retention of the placenta. Strassman, quoted by these authors, considers pregnancy in a case of double uterus to be quite as dangerous as ectopic pregnancy. Jung reports a case of a nineteen-year-old girl with uterus duplex, in which a full-term child was born dead after a difficult extraction. Her next pregnancy was in the opposite uterus and was complicated by a breech presentation which also resulted in the birth of a dead child.

There are many case reports in which cesarean section has been performed owing either to the fear, or actual existence, of serious dystocia or other complications.

Meyer-Ruegg reports a case of abruptio placentae in a patient with a septate uterus. This occurred at six and a half months, and it was thought that abortion may have been due to rupture of the uterine septum.

Fall states that in these cases prolonged gestation, long labor, weak pains, operative deliveries and postpartum hemorrhages are frequently encountered.

Hans Binder reports a case of a woman with uterus bilocularis who had two spontaneous births of living children. Menstruation in the third pregnancy ceased for eight months, at the end of which time the patient flowed freely and the fetal heart sounds ceased. After determining that the fetus was dead, supravaginal hysterectomy was performed. The patient recovered.

The tolerance of the pregnant uterus in these cases is of interest. Kaminsky reported a case in which the pregnancy was diagnosed and interruption advised. The nonpregnant uterus was curetted without interrupting the pregnancy on the opposite side.

Garfunkel reports a case of double uterus in which both halves were pregnant, one conception having preceded the other. In this case one of the uteri was emptied without disturbing the other, although a sound was introduced into the supposedly nonpregnant uterus.

Vandescal and Kermeis report a case of twin pregnancy in a double uterus, in which one birth preceded the other by forty days. The patient secreted no milk after the first child, but after the birth of the second she produced sufficient for both infants. These authors suggest that the presence of the placenta and fetus of the second child may have been the cause of failure of the milk to appear after the first birth.

Gänssbauer reports a case of cervical pregnancy, in which a diagnosis was made of infected miscarriage with placenta praevia and a dead child. Panhysterectomy was performed and the specimen obtained showed that the cervix was unusually long and the body of the uterus correspondingly short. The placenta and fetus were entirely confined to the cervical cavity. The cause of this anomaly was ascribed to an infantile uterus. Gänssbauer advised cesarean section in these cases if the child is viable.

The danger of errors in diagnosis in anomalies of the genital tract is well illustrated by the following case report by Neumann. The patient was a young girl, aged twenty-three, who had never menstruated, in whom a diagnosis of pregnancy was made by a physician. She was examined by another physician who, thinking she had an imperforate hymen, dilated with the finger the urethra instead of the hymen. This procedure was followed by considerable bleeding which was mistaken for menstrual bleeding. After the fourth dilatation of the urethra the girl consulted a physician and admitted having had sexual congress. Three months thereafter she returned to her physician and again reported that she had not menstruated. The physician said she was pregnant. The patient, feeling no symptoms of pregnancy, consulted another physician, who referred her to the Frauen Klinik (Marburg) where an examination was made which revealed an aplasia of the vagina and uterus and a very much dilated female urethra. The following diagnosis was made: Aplasia of the vagina, arrested development of the uterus, hypoplasia of the ovaries, and an unusual enlargement of the urethral opening.

Strassman and Fuchs have reported living, not always full-term, children, following metroplastic operations. Strassman's operation has been done to relieve menstrual troubles and with the idea of making pregnancy possible in cases of repeated miscarriage or of pregnancy not carried to full term.

Von Klein reported, up to 1926, there had been a total of 6 cases of pregnancy following metroplastic operations for double uterus. He described a case of double uterus in which the uterine septum was removed following a curettement for an incomplete abortion. He gave this patient contraceptive advice for six months after operation before permitting her to become pregnant. He was extremely careful in the conduct of labor and in order to minimize the strain on both the uterine and abdominal scars, labor was facilitated by performing an episiotomy and resorting to low forceps. The child lived.

So far as we have been able to ascertain there have been 9 living children reported following metroplastic operation in cases of double uterus.

The favorable results mentioned above indicate the possibilities of gynoplastic reparative surgery in selected cases of congenital anomalies. These results should encourage the interest of gynecologists and obstetricians in this type of surgery.

The following case report of the author may be of interest:

A patient, age thirty-five years, was first seen in consultation because it had been discovered by her physician that she had a double vagina and a double cervix. She was in her fourth month of pregnancy and a consultation of physicians had advised interrupting the pregnancy because of this anomaly. The patient desired further advice. Inasmuch as there were no other abnormalities apparent in this healthy woman, the author advised that the pregnancy

PUERPERAL FEVER

Although puerperal fever was known to the ancients, yet deaths from infection following shortly after childbirth were infrequent, no doubt due to the non-interference practiced by the midwives. It was not until the development of operative procedures requiring the introduction of the hand into the parturient canal and the establishment of lying-in hospitals that epidemics of puerperal fever began to be recorded.[1] The first accurately recorded epidemics date from the middle of the seventeenth century. Reference to what was apparently puerperal fever is found in Hippocrates,[2] who mentions that the wife of Dromeades had a chill the second day after her delivery; her death occurred on the sixth day. In the writings of Celsus, Aretæus, and Oribasius there appear no references to what may be definitely recognized as puerperal infection. Aëtius, author of the *Tetrabiblion*, although he devotes twenty-five chapters to midwifery and thirty-five chapters to diseases of women, mentions inflammation of the womb only in connection with abortions.

Because of its postpartum incidence, puerperal fever was looked upon as a distinct disease entity and in practically all disease classifications, well into the nineteenth century, it is so designated. The pathologic picture, delineated with fair accuracy a century ago, has now been differentiated so clearly that it would seem that little doubt can be entertained as to the sources and tissue selectivity of the infection. In spite of present-day progress, however, many phases of postpartum illness involving fever, manifestly due to infection, are puzzling and the end of the chapter on the etiology of puerperal infection has not been written.

Students of embryology and midwifery are familiar with Harvey's *De Generatione*.[3] This work contains a significant paragraph in the chapter "On the Birth" in which Harvey likens the placental site to a "vast internal ulcer."

"Women, as they alone have a menstrous, so have they alone a lochial discharge; added to which they are exposed to disorders and perils immediately after birth, either from the uterus, through feebleness, contracting too soon, or from the lochia becoming vitiated or suppressed. For it often happens especially in delicate women, that foul and putrid lochia set up fevers and other violent symptoms. Because the uterus, torn and injured by the separation of the placenta, especially if any violence has been used, resembles a vast internal ulcer, and is cleansed and purified by the free discharge of the lochia. Therefore, do we conclude as to the favorable or unfavorable state of the puerperal woman from the character of these excretions. For if any part of the placenta adhere to the uterus, the lochia discharges become fetid, green, and putrid; and sometimes the powers of the uterus are so reduced that gangrene is the result, and the woman is destroyed."

Numerous paragraphs may be cited from Thomas Willis (1621–1675), and the *Aphorisms* of Hermann Boërhaave (1668–1738), frequently quoted by his pupil Gerhard van Swieten (1700–1772), emphasizing the presence of a wound in the uterus due to the separation of the placenta, and fever as a result of wound infection was not unknown to Harvey, Willis, Boerhaave, and to other late seventeenth and early eighteenth century writers.

[1] Hirsch in his *Handbuch der Historisch-geographischer Pathologie* enumerates 288 epidemics, 178 occurring exclusively in lying-in hospitals. He quotes Lefort as showing a death rate in hospitals of 3.4 per cent; a greater number delivered in homes show a rate of 0.47 per cent.

[2] Case XI, in the first book of *Epidemics*.

[3] *Exercitationes de Generatione Animalium*. London, 1651.

others have thought that a 1 per cent aqueous solution of genitian violet applied to the vaginal mucosa was specific. Alkalines have also been recommended by Cron and others. At the present time the author has a case of Monilia vulvovaginitis, in a patient five months' pregnant, which is very rebellious to treatment and so far has not responded to gentian violet nor alkaline preparations nor any other form of local treatment.

The Monilia organism is stained for diagnostic purposes with the ordinary solution of methylene blue.

Summary.—Lower genital tract infections are extremely common complications of pregnancy. Gonorrheal organisms and Bacilli coli communis are the most frequent offenders.

Gonorrhea in its acute and chronic forms should be treated conservatively during pregnancy because of the danger of abortion and ascending infection.

A bacteriological investigation should be made in all cases of troublesome leukorrhea occurring during pregnancy.

Trichomonas vaginitis and Monilia vulvovaginitis are occasionally sufficiently severe to require palliative treatment during pregnancy.

At the present time the writer knows of no specific cure for either trichomoniasis or the Monilia infection, although relief of symptoms can be obtained.

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CHAPTER XXXII

SPONTANEOUS ABORTION AND PREMATURE LABOR

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In this country and in the British Isles the term "abortion" has heretofore been limited to the expulsion of the ovum during the first three months of pregnancy. "Miscarriage" was employed to designate the interruption during the remaining period of nonviability. While there may be justification in the use of such differentiating terms, because of the different clinical pictures before and after the formation of the placenta, most authorities now think their use is unnecessary, confusing and unscientific, and prefer to use the word abortion to designate any termination of pregnancy before the twenty-eighth week of gestation, when the fetus becomes viable. With the laity, however, it will be difficult to eliminate the use of the term "miscarriage" because they so frequently attach a criminal meaning to the name abortion. In English-speaking countries, in recent years, there has been a growing tendency to drop the term "miscarriage" and to follow the European custom of employing the more logical term "abortion" for any termination of pregnancy before the fetus is capable of independently maintaining its extra-uterine existence.

There are contrasting clinical and pathologic aspects, characteristic of abortions occurring during the first six weeks of gestation and those in the next six weeks, also between these two and expulsions which occur after the placenta is formed. Therefore, Taussig[78] and others call these three periods the first, second, and third stage of abortion, which have a much sounder basis than abortion and miscarriage. The author designates them—the decidual stage or early abortion, the attachment stage or intermediate abortion, and the placental stage or late abortion.

INCIDENCE

The incidence of abortions is probably not less than 20 per cent. Statistics, however carefully analyzed, cannot yield an accurate estimate because hospitalized cases are not an index of the general situation, nor do specialists' figures represent a cross section of the practice of obstetrics. Thoroughly reliable histories cannot be obtained from women themselves because of inaccurate memory and hesitancy to confess criminal interference, and many women have early abortions without ever knowing it. Yet, however inaccurate statistics may be, they do give us a general idea of the situation. In this country abundant data show that criminal abortions are growing rapidly. Taussig[78] asserts that in his experience one half of all abortions are criminally produced. Even if these figures be too high, they indicate an alarming situation. In Germany conditions are appalling and in Russia abortions are not only legalized, but the state provides "abortoriums."

Taussig[78] found the astonishing proportion of one abortion to every 2.3 full-term births (43.4 per cent). He also quoted Macharloff, who reported one of the largest series, 257,988 conceptions of which 10 per cent ended in abortion. That the proportion of one abortion to five viable births is not far wrong, is supported by authorities from many countries: Taussig, 43.4 per cent; Macharloff, 10 per cent; Kayssner, 17.8 per cent; Alfeld, 20 per cent; Stumpf, 28 per cent; Meyer, 21.8 per cent; Schultz, 22 per cent; Hellier, 21.7 per cent; Franz, 16.8 per cent; Whitehouse, 17.2 per cent; Malins, 16 per cent —average 19.3 per cent.

When we consider that the true frequency is, in all probability, greater rather than less than these estimates and that criminal interference is increasing the incidence, we must realize that abortions are too common. This, together with the rapidly decreasing number of conceptions, must soon make the birth rate approach, or even fall below the death rate; thus we will soon be facing a serious economic situation, as well as a disconcerting medical problem.

The relative frequency of abortion differs in the various months of gestation. It is greatest during the third month, next in the second month, gradually decreasing in each succeeding month until viability. The incidence during the first and second months is about the same, according to statistics, but there are probably many cases which are not recognized in the first month.

Incidence of Abortions by Months.—The combined figures of Stumpf, Franz, Blondel, and Lantos (all quoted by Seitz[75]), and Kneise (Taussig[78]) amount to 1762 abortions, of which 9 (0.6 per cent) occurred in the first month, 521 (29.6 per cent) in the second month, 738 (41.9 per cent) in the third month, 219 (16.9 per cent) in the fourth month, 139 (7.8 per cent) in the fifth month and 56 (3.2 per cent) in the sixth month.

Approximately three fourths of abortions occur during the second and third months.

Parity.—It is certain that there are more abortions among multiparae, but whether the proportion is greater than the relative number of multiparous and primiparous births may be questioned.

ETIOLOGY

The etiology of abortion is not completely known. There are many alleged causes, but few of these have been fundamentally established. As we study the pathology we must be impressed by the fact that certain morbid conditions are constantly found; for example, bleeding, degeneration or improper development show that there has been interference with the implantation, maintenance of the conception or nourishment of the ovum. It is evident that these etiologic factors must reside in the ovum itself or in its environment; the endometrium, the decidua and the placenta. It is on account of the difficulty of detecting the inherent deficiencies of the ovum and the many local and general physiologic and pathologic conditions which may deleteriously influence the uterus, that renders the task of solving the problem of the etiology of abortion so arduous. There are many cases in which there is no discoverable cause, even by the most expert clinical, embryologic or pathologic investigation. Abernethy[1] could find no cause in 28 per cent, and Verrucoli[82] in a large series of 2307 abortions could discover

no etiologic factor in 68.61 per cent. One of the great burdens laid upon us, is to aid by every possible investigation, clinical or experimental, in the solution of this great enigma.

Causes Inherent in the Impregnated Ovum.—Spermatozoa, as well as ova, are peculiarly susceptible to deleterious influences so that the impregnated ovum may be lacking in vitality, which interferes with the proper development of the fertilized ovum. The subnormal condition of the sperms is due to several conditions; some of them in every ejaculation are morphologically and physiologically incapable. Lowered vitality of the gonads may result from general poor health, venereal disease, toxins, chemical or bacterial, advanced age, inflammation of the seminal vesicles or disturbed endocrine influences. In seeking the cause of abortions and sterility, factors in the male are too often neglected. It is not sufficient to see motile male cells for they may be faulty in morphology or vitality, as evidenced by reduced motility and the presence of excessive mucus or pus.

Causes Due to Abnormalities of the Endometrium, Decidua, and Placenta.—A vast majority of abortions can be traced to abnormalities of the endometrium, decidua, and placenta. Most of the diseases and conditions which cause abortion exercise their deleterious influences by interfering with the physiology of reproduction or by producing pathologic changes in the decidua and placenta, which in turn affect the embryo or fetus. The cyclic changes in the endometrium, every month, prepare it for the implantation of the impregnated ovum. The cycle is dependent upon the normal functioning of the glands supplying the hormones, chiefly the ovaries, through stimulation by the anterior lobe of the pituitary gland. Therefore, anything which disturbs the integrity of the endometrium, or its response to the hormones, will interfere with normal nidation and the nourishment and development of the ovum, resulting in abortion. Whitehouse[37] expresses this idea well: "It is evident that impairment of nutrition from faulty implantation, absence of essential food factors and the existence of lethal toxins are potent factors in abortions."

Endocrine Disturbances.—The influence of the hormones upon gestation is quite well known, but no attempt will be made, at this juncture, to detail the present status of the knowledge of the hormonal influences on the generative organs. *For this fascinating story, consult Chapters IX, X, XII and XIII, and Section XVI, "The Endocrines in Gynecology and Obstetrics."*

Suffice it to say that two of the several hormones of the anterior lobe of pituitary gland stimulate the ripening of the ovarian follicles and the production of folliculin (oestrin, theelin), which then stimulates the regeneration of the endometrium after menstruation up to the pregravid stage of the cycle, where the corpus luteum takes up the burden. It is also stimulated by the secretion of the anterior lobe of the pituitary gland to produce lutein cells and causes them to secrete lutein (progestin) which activates the completion of the regeneration of the endometrium through the premenstrual (pregravid) stage of the menstrual cycle. The endometrium is now prepared for the implantation of the ovum.

It seems logical to conclude that any disturbance of these endocrine functions will interfere with the nidation, growth, nutrition, and development of the ovum—hence a cause of abortion. It has been known, clinically, for many years that removal of the corpus luteum early in pregnancy would

cause abortion. This has been shown to be due to the absence of the corpus luteum hormones, particularly progestin, which maintains the integrity of the pregnancy during the first month and probably to the end of the third month of gestation. Likewise, disturbed function of the anterior pituitary lobe and ovary produces an abnormal endometrium unfavorable to nidation, causing sterility, or if conception does occur, the implantation of the ovum takes place in decidua unfavorable to continuance of the gestation, resulting in abortion.

Frank[20] insists, with justification, that the failure to apply the known functional tests for determining the amount of the female sex hormone and the pituitary maturity factor in the blood and urine is as reprehensible "as neglecting to determine the basal metabolic rate in thyroid disturbances, to fail to obtain electrocardiograms in cardiac disease or to neglect the study of blood sugar in diabetes." While it is easy to understand why hypofunction should cause amenorrhea, oligomenorrhea, and sterility, it is difficult to account for the bleeding, which, as Frank[20] says, "emphasizes the fact that little or nothing is known of the mechanism of menstruation." On the other hand, we can easily account for the bleeding in hyperfunction, which stimulates marked cystic endometrial hyperplasia or dysplasia. That is what we would expect on account of the excess of folliculin. If there be hyperplasia or dysplasia of the endometrium, as in the presence of myomata, retroversions, subinvolution, and retention cysts of the ovary, or if it is injured by infection or responds abnormally to hormonal influences, the environment of the ovum is abnormal, resulting in improper nourishment, abnormal ova, and abortion. We have, then, the underlying and primary causes of the defective germ plasm, which was rated by Huntington[31] as the commonest cause of abortion.

Research is gradually solving the mystery of the endocrines. New discoveries are constantly altering our view while bringing us nearer to the facts. When the workers in this field shall have solved the problem, we will understand the mechanism of the endocrine control of the reproductive processes, and why these are disturbed by endocrine dysfunctions. Our knowledge of the etiology of abortion will then be on a more scientific basis. The author believes that more abortions are due to disturbed endocrine function than is generally supposed. There are a growing number of clinical observations in medical literature voicing this same belief. While science must give us the final answer, it may not be amiss to record some of the clinical evidence, inconclusive though it may be.

Whitehouse[87] attributed unfit decidua and consequent abortion to follicular and corpus luteum secretions. In fibroids and retoversions there are frequently found pathologic conditions of the follicles and corpus luteum, so it is conceivable that the factor which kills the fetus and leads to abortion may be the follicular and lutein lesions. He also propounds the ingenious theory that abortion, following mental shock, may be due to nervous influences exerted upon the ovary, causing inhibition of follicular and corpus luteum secretion.

Vignes,[53] in 1927, laid much emphasis upon the insufficiency of the glands of internal secretion as causes of abortion and attributed defective germ plasm to endocrine sources.

J. Novak[52] observed that when he gave potassium iodide, on the theory

that abortion is due to syphilis, nonluetic patients were also benefited. He attributed these favorable results to iodine stimulation of the thyroid gland.

Abruzzi[2] also emphasized the dysfunction of the thyroid in the pathogenesis of abortion.

Alice White,[83] in a considerable series of dispensary patients in London, used thyroid extract in all women who had previously aborted or had premature labors, with the result that 90 per cent delivered normally.

Huntington[31] believes that faulty endocrine function, especially deficient thyroid secretion and the defective development of the corpus luteum and anterior pituitary hormones, are potent factors in abortion. He says, further: "The continuance of gestation depends not only on the normal development of the impregnated ovum but also on the normal development of the decidua, controlled by the corpus luteum. It is possible that the same factors may operate in the male by endocrine effect upon the gonads, resulting in defective sperms."

Macomber[43] asserts that there is a close relation between relative sterility and abortions, logically concluding that they are due to similar fundamental causes. "Forty-six per cent of relatively sterile women abort—more than twice as many as the number occurring in women in general."

Lotka[41] estimated that 13 per cent of women in general abort. Twenty-five per cent of all of the specimens obtained from cases of abortion which came to Mall and Streeter were from childless women. The author[39] and J. B. Carey[40] demonstrated, clinically, the endocrine relation to the function of reproduction by observing that 57 per cent of previously sterile women had low basal rates and that 28.8 per cent of them had aborted, some of them repeatedly. Thirty per cent of these conceived after thyroid medication and, by keeping the metabolism rate normal, none of them aborted. Of course, not all women with low basal metabolism have thyroid deficiency; there are other endocrine causes.

Greil[27] also urged that the basal rate should always be estimated as a prophylactic measure against abortion.

J. Novak[52] was convinced of the rôle of hypothyroidism in the etiology of abortion by his success in administering iodine to women who had habitually aborted.

Experimentally, also, there is sound evidence of the endocrine causes of abortion, both by hypofunction and hyperfunction.

Hammett[23] observed that in thyroidectomized rats the hypophysis was hypertrophied and the ovaries and uterus were retarded.

Zondek[91] found that large doses of folliculin produced abortion in animals and also that by increase of the physiologic prolan concentration in the blood during pregnancy, by introducing additional amounts of the hormone, abortion was produced.

Defective Germ Plasm.—The confused status of the etiology of abortion assumed more of a scientific aspect when His and, later, Mall[44] and his associates called attention to the fact that embryological defects were frequent causes of fetal death and abortion. Mall noted the following embryological defects: the embryo a mere nodule, no embryo at all, only the stump of a cord; commonly encountered spina bifida, anencephalus, and monsters in those fetuses which survived. He favored environment as the chief etiologic factor and cited, in support of his contention, the large number of abnormal

pathologic ova found in ectopic pregnancies and in inflammatory conditions of the endometrium. Mall asserted that these abnormalities were due to defective germ plasm and believed that these internal causes were far more frequent than external influences, such as trauma, myomata, and retroversions. Some of these fetal anomalies render further development impossible; therefore, they are seen only in early embryos. They are twelve times as frequent as full-term monsters. The associates and successors of Mall, and many others, are continuing to accumulate further evidence that the rôle of defective germ plasm, as an etiologic factor, is firmly established.

Of 100 ova, expelled intact, Reuther and Pigneaud[62] found 30 incapable of developing and doomed to precocious expulsion. Macomber[43] asserts that "only 20 per cent of embryos in the first month are normal, 50 per cent in the second month; 90 per cent are normal in the third and fourth months. There are no abortions due to defective germ plasm during the last half of pregnancy. Monsters at birth are due to defects which were not sufficient to cause the death of the fetus." Huntington[31] found 82 of 85 per cent of inevitable abortions were due to defective germ plasm and, therefore, declares that this is the chief cause of abortion. But what is the cause of defective germ plasm? Does it originate in the ovum or the spermatozoon and is it thus inherent in the fertilized ovum, or is it a result of unfavorable environment? The query cannot be answered by the microscope because the evidence is only that of behavior.

Streeter defines "defective germ plasm" as follows: "It must be understood that defective germ plasm is described on the basis of behavior rather than microscopical appearance. The defective egg is one that does not develop properly, rather than a characteristic histologic appearance of tissues." On the other hand, Robinson,[65] working with ferrets, proved that it may be inherent by calling attention to the death of some embryos in the same litter with perfectly normal ones. "Death was not due to inflammation or environment, but simply to an incapability of certain embryos to live and develop properly under conditions quite favorable to adjacent embryos." This incapability he attributed to structural peculiarities, inherent in either the ovum or the sperm. He declared that the widespread belief that prenatal death is largely, if not entirely, due to disease was erroneous, even though it had received strong support from Mall, who asserted that an embryo which had reached a comparatively advanced stage before it showed obvious signs of degeneration was originally normal. Robinson contended that his work showed this idea to be untenable, maintaining that the sperm or ovum may have invisible structural defects which may result in a breakdown later. He also said that the regression of the dead fertilized ovum is often erroneously described as degeneration and given as the cause of the abortion. It has been shown also that in litters of pigs of 12 eggs, *all subject to the same environment*, as many as 25 per cent of them are not good enough to reach birth alive. Ova are not alike in their ability to develop in the face of hardship. A similar incidence appears to be true of man and it is just such specimens that make up a large part of the material that the physician encounters in arrested pregnancies. A considerable incidence of prenatal death is inevitable, due to the inability of the ovum and sperm of certain individuals to unite properly and this is not always due to diseases or abnormal environment of the parents. The tiny egg not only possesses potential forces which ordain

its ultimate morphological characteristics and mental attainments, but also determine what endurance it shall have in meeting the various vicissitudes of life from the very beginning of its existence. Both inherent conditions of the ovum and unfavorable environment cause defective germ plasm, death of the fetus, and abortion.

Inflammation of the Uterus.—Deciduitis, inherited from a previous endometritis, is undoubtedly a cause of abortion, but probably not so frequently as has commonly been assumed. It is quite true that round-cell infiltration is found in the endometrium and decidua, so often indeed that many authors insist that endometritis and deciduitis are the commonest causes of abortion. This phase of the etiology needs to be restudied, not so much to discover whether uterine inflammation is a cause of abortion, for that is well established, but rather to determine how frequently it is the real cause. To do this, any attempt at artificial induction which would cause inflammation mechanically or bacteriologically must be excluded unequivocally, if the case is to be considered a spontaneous abortion due to deciduitis.

Mall[44] found that abnormalities of the fetus resulting in abortion were frequently associated with, even if not necessarily caused by, uterine disease. The evidence of inflammation in the endometrium and decidua is frequently so profound that one cannot doubt the preexisting disease as a cause. On the other hand, Huntington[31] believes that endometritis plays a very small part in the etiology of abortions and Verrucoli[52] found, in a series of 2307, that less than 1 in 25 could be traced to endometritis. Abernethy[1] could establish endometritis and deciduitis by thorough microscopical study as the cause in only 8 per cent of his cases. Even the figures of Whitehouse,[57] who found nearly 27 per cent with pelvic inflammation, would not place inflammation as the most common cause. Inflammation of the uterus produces abortion in the same manner as do the endocrines, by creating an unfavorable environment. The inflammation prohibits the formation of normal decidua; therefore, the nidation, nourishment, and development of the ovum are abnormal, resulting in death of the embryo and consequent abortion. As Streeter and Meyer put it: "It does not seem improbable that an inflamed endometrium can so alter the growth of an embryo as to cause its death and rejection."

Infectious Diseases.—The germs of infectious diseases and of focal infections may reach the endometrium through the blood stream and create the same unfavorable environment for the ovum as primary uterine inflammation. Infectious diseases sometimes, though relatively infrequently, cause abortion. In India, Das[12] said that 38 per cent of abortions were due to malaria. In certain very virulent epidemics, notably the epidemic of so-called "influenza" in 1918 and 1919, pregnant women seemed foredoomed to premature interruption of gestation. Typhoid fever (Laffont and Mele[34]), actinomycosis (Bax[5]), pneumonia, appendicitis, and most other infectious diseases may occasionally cause abortion, but they are not usually serious factors.

Brucella Abortus.—When the cause of infectious abortion in cattle was identified as Bang's Brucella abortus, it was natural to suspect that this might also be found to be a cause of abortion in women. However, only Carpenter and Book[10] have definitely isolated Brucella abortus from a human

aborted fetus, although Larson and Sedgwick,[35] DeForest,[14] Whitehouse,[87] and others have reported abortions in women on farms, where there were epidemics of infectious abortion in cattle.

Focal infections are not common causes of abortion, but they are etiologic factors frequently enough to make it advisable, particularly in habitual abortion, to search for infectious foci. Curtis[11] reported 3 childless women, who habitually aborted. They all had active foci of infection, after eradication of which two of them bore healthy children and the third, who had had 11 abortions, was six months pregnant at the time of the report. Intravenous injections of pregnant rabbits with hemolytic streptococci from these patients invariably resulted in prompt abortion. Curtis laid particular emphasis upon the fact that in all of his cases there were acute exacerbations in the old foci. The acute exacerbations were more probably the cause of the abortions than the chronic infections. Ruth[71] also produced abortion in 4 pregnant rabbits and hemorrhage in the uterus in 8 of 10 nonpregnant animals, with streptococci obtained from the tonsils and placentae of women who had repeated spontaneous abortions. In 13 rabbits, given injections of throat cultures from the same women ten months after tonsillectomy, no lesions of the uterus were seen.

Nickel and Mussey[53] injected 7 guinea-pigs with freshly isolated streptococci from foci of women who had aborted. Six of the 7 guinea-pigs aborted and the organism was recovered from the blood of 3 of them, from the uterus of 5, and from the blood of 6 of 12 aborted fetuses.

These reports, with many others, thoroughly establish focal infections, especially when lighted up acutely, as causes of abortion. Here, again, the mechanism is the same; interference with implantation, abnormal decidua, death of the fetus and consequent abortion.

Toxins.—Datnow[13] studied histologically the placenta and its site of implantation, following the intravenous injection of various toxic substances to determine the processes concerned in toxic abortion. Into the ear vein of rabbits he introduced colloidal lead, cadmium, selenium, aspartic acid, sodium aspartate. He also injected the so-called "emmenagogue oils" of pennyroyal, tansy, and juniper, none of which produced abortion. All lead salts produced, first, coagulation necrosis of the decidua or placenta; second, hemorrhage into the placenta and its site and throughout the whole uterus. Degeneration and separation of the trophoblast subsequently occur. Bleeding appeared to be the primary cause of the abortion, rather than the death of the embryo. Almost identical pathologic changes, followed by abortion, were produced by inducing nephritis, by Hofbauer[30] by giving histamine, by Morse[48] by ligating the veins in one horn of the pregnant uterus of rabbits, and by Blair Bell[6] who injected lead. Zamboni[90] reported a case of abortion due to corrosive sublimate and Nicolleti[51] one from eating poisonous fungi. Datnow further asserts that the same degeneration may be initiated by bacterial or biological toxins. Again we see that, whatever the agent, endocrine disturbance or infection or chemical toxins, the immediate cause is always similar; interference with the decidua or placenta and consequent abortion.

Syphilis was formerly believed to be the chief cause of abortion, but with the discovery of the cause of lues, the development of the diagnostic Wassermann test and its modifications, the advance in our knowledge of the

Two delightful essays have been written on Charles White and his work: the first by J. G. Adami[1] (1862–1926) and the second by Charles J. Cullingworth[2] (1841–1908). Adami pictures White as an outstanding pioneer in midwifery, a leader in medical and surgical thought. Cullingworth in an address before the Medical Society of Manchester, October 7, 1903, used Charles White as the central figure. Adami's first essay was later enlarged[3] to include a republication of certain portions of Charles White's treatise (1773). The advanced position taken by Charles White in the prevention and management of puerperal fever and the sequence of events that led from White to Louis Pasteur[4] (1822–1895) and Lord (Joseph) Lister[5] (1827–1912) merit careful study. The wonder of it all is that such outstanding progress in preventing puerperal fever, all but proving the complete etiology, should have been within the grasp of so many widely scattered observers with so little effect upon the practice of midwifery of the time or of that of the two or three generations immediately succeeding.

One cannot read Charles White's book[6] (Fig. 47) without sharing to the full the admiration for his work held by Adami, Cullingworth, and his biographer, Thomas Henry[7] (1734–1816), who says:[8]

". . . . few medical books have been productive of more important reform in medical practice, or of more comfort and safety to the subjects for whose benefit it was intended."

White viewed child-bed fever as an absorption fever. Many writers, as in the opening quotation from Harvey, had mentioned, as a general symptom of puerperal fever, the diminution or suppression of the lochial flow. White noted that frequently prior to the onset of the chill, the lochia became foul. Of the rôle of retained lochia, White says:

"The lochia stagnating in the womb, and in the folds of the vagina, soon grow putrid,

[1] *Charles White: Surgeon and Obstetrician. Medical Library and Historical Journal*, Brooklyn, New York, 1907, vol. v, p. 1. John George Adami, of Italian descent, was born at Manchester and studied at Cambridge. In 1892 he went to McGill University as the first professor of pathology. In 1919 he became vice-chancellor of the University of Liverpool.

[2] *Charles White, F. R. S., a great provincial surgeon and obstetrician of the eighteenth century*, London, 1904. Charles James Cullingworth studied at Leeds School of Medicine; M. R. C. S., 1865; became surgeon to St. Mary's Hospital for women, Manchester, in 1873. He received his M. D. at the University of Durham, 1881, and in 1885 was appointed to the chair of obstetrical medicine at Owens College. In 1887 he was elected a fellow of the Royal College of Surgeons of London.

[3] *Charles White of Manchester (1728–1813), and the Arrest of Puerperal Fever*, being the Lloyd Roberts Lecture, Manchester Royal Infirmary, 1921. London, 1922.

[4] Louis Pasteur, French chemist, founder of the science of bacteriology, discovered the etiology of several disease entities, and paved the way for a life-saving program of incalculable magnitude; the world's most eminent biologist.

[5] Lord Joseph Lister, born at Upton, Essex, applied Pasteur's fermentation theory of disease to surgery and made possible the widespread development in that field.

[6] *A Treatise on the Management of Pregnant and Lying-in Women, and the means of curing, but more especially of preventing the principal disorders to which they are liable*, London, 1773.

[7] Thomas Henry, chemist, practiced as a surgeon-apothecary in Manchester. He was a member of the Manchester Literary and Philosophical Society. He translated Antoine Laurent Lavoisier's (1743–1794) *Chemical Essays* and was the first to show the utilization of carbon dioxide by plants.

[8] *Memoirs of the Literary and Philosophical Society of Manchester*, series 2, vol. iii, 1819.

TREATMENT

Prophylaxis.—Until the causes of abortion are better understood, the prevention will always be difficult. The efforts to discover the fundamental etiology must be intensified. Scientists are doing their part in studying the physiology of pregnancy, especially the rôles of endocrines. Clinicians have made meager contributions. It is they who must intensify their efforts by clinical investigation and cooperation with the embryologist and pathologist, and by saving their specimens for study. Failure of endocrine medication is due to the fact that concentration and dosage for women have not, as yet, been perfected. That does not disprove the control of the endocrines over gestation, but means only that the proper method of administration is not yet determined. The unknown will not discourage, but will stimulate scientist and clinician to greater efforts to penetrate the darkness.

Threatened Abortion.—"Immediate" is the *sine qua non* in the treatment of threatened abortion. At the first evidence of the premonitory signs, dragging backache, heaviness in the pelvis, crampy pains, however slight, or any evidence of blood, no matter how little, the patient must be put to bed immediately and given $\frac{1}{4}$ grain of morphine at once. This may be combined with atropine or hyoscine. It is a good plan to give a rectal suppository containing 1 grain of opium, which by its continuous slow absorption, enhances and maintains the narcotic effect of the morphine. This is no time, except in the absence of pain, to play with the lesser alkaloids of opium or other sedatives. Narcotic action, sufficient and complete, is demanded. Prompt results must be secured by repeating the medication every four to six hours until the process is stopped. By striking quickly and hard, the issue will be promptly decided one way or the other and much time saved and prolonged medication avoided. After pain and bleeding have been stopped, the drugs should be discontinued. The woman must remain in bed several days or a week after cessation of symptoms. It is best not to make vaginal examinations during a threatened abortion because of the danger of irritating the uterus into an inevitable abortion. Cathartics should be avoided for the same reason. When symptoms have ceased, the bowels may be emptied with avoidance of straining by giving a small retention enema of water to soften the feces, a few hours later an oil enema to lubricate, and a short time after this a large enema to stimulate expulsion. If in doubt about the condition being an abortion, especially if extra-uterine pregnancy cannot be excluded, a bimanual examination must be made to insure a correct diagnosis.

When treatment has stopped the pain, but bleeding persists, one wonders how long it should be allowed to continue. It is usual, if the bleeding is not more than that of a normal menstruation, to wait before emptying the uterus. When one has decided to allow conditions to continue with the hope of preserving the pregnancy, he should make daily blood examinations to be sure that the health of the mother is not being endangered by the small daily loss of blood. It is generally considered useless, if bleeding persists, to continue treatment for more than ten days or two weeks, in any event, because after elapse of that time the abortion is inevitable. This is not invariably true, for the author has seen many cases that bled moderately for several weeks and yet went on to full term. One must not decide, only by the lapse of time, that a threatened abortion has become inevitable. In

the absence of great bleeding or rapid fall in hemoglobin one would be justified in delaying two or three weeks to determine if the ovum is alive and growing. If the uterus increases, it is probably alive; if stationary or decreasing in size, in all probability the fetus is dead. Delay may be avoided by determining whether the ovum lives by the modified Aschheim-Zondek test, which, in the case of death, would be negative. A positive test, however, does not insure a living fetus, for the placenta occasionally remains alive, nourished by maternal blood, after fetal death. (See Missed Abortion, p. 1105.)

Inevitable Abortion.—If the fetus is dead, there is no need for delay in "clean" spontaneous abortion cases. The abortion is inevitable, so time, effort, blood, and the health of the patient may be conserved by terminating the pregnancy. The best method to employ, whether expectancy or emptying, will depend upon the amount of bleeding and the degree of dilatation of the cervix. If the os will admit one, or better, two fingers, the ovum may be separated intact or piecemeal. Any small pieces which cannot be grasped, may be removed by the special placental forceps or by the ring sponge holder. When the cervix is not sufficiently dilated, it may be enlarged by the finger or metal dilators under general or local anesthesia. Deliberate, slow stretching will avoid the tears which, when the cervix is soft, occur so easily. The cervix is almost never so rigid or undilatable that it cannot be dilated under gas anesthesia. In cases of pregnancy beyond the second month it may often be bisected, anteriorly, with advantage. The custom of accomplishing slow dilatation by packing the rigid cervix with gauze or by insertion of a laminaria tent, followed by curettage twenty-four hours later, is pernicious and dangerous. In emptying the uterus during the early months of gestation the entire procedure should be accomplished at one sitting.

The danger of perforating the soft uterus is considerable. All instrumentation of the pregnant uterus must be done with judgment, skill, deliberation, and gentleness. Packing the uterus after the cavity is empty is usually unnecessary and is dangerous.

Therapeutic Abortion

The progress of modern medicine has greatly reduced the necessity for therapeutic abortion. It is noteworthy that coincident with the recent alarming increase of criminal inductions, the justifiable indications have been greatly narrowed. The conscientious physician only recognizes impending death and life-threatening conditions as warranting deliberate termination of pregnancy before viability.

No one physician should undertake the grave responsibility of a therapeutic abortion without consultation, not only for support of his judgment, but also to protect his reputation. Conditions which were formerly considered certain indications are, by the advance of our knowledge, no longer necessary; for example, marked contraction of the pelvis is now handled by cesarean section, ovarian tumors by removal, diabetes by dietary regimen and insulin, and exophthalmic goiter by medical and surgical treatment. Cancer may not be an indication for emptying the uterus; pregnancy is rare in body cancer and cervical carcinoma, if early, may be treated without considering the gestation. If very far advanced, no treatment will avail, and it may then be ignored in the interests of the child, which should be delivered according to the conditions present at term.

Pregnancy, complicated by uterine myomata, rarely requires abortion. The possible mechanical interference need give no anxiety, for myomectomy may be done when, in rare cases, it is necessary, or the pregnancy may be allowed to go to term and handled as indications warrant. (See Chapters XXXIV and LVIII.)

Positive Indications for Therapeutic Abortion.—*Toxic Vomiting.*—An overwhelming majority of cases of hyperemesis are neurotic in character, and respond to treatment, but a few are due to true toxemia so severe as to endanger the patient's life. The comparatively recent recognition of the neurotic basis of excessive vomiting, in most instances, has done two valuable things: it has rendered the treatment more successful and for that reason has made the recognition of the toxic cases easier. When convinced by failure to respond to therapeutic measures and other evidence that the case is toxic, abortion should be induced at once. (See Chapter XXX.)

Hydatidiform Mole.—As soon as the diagnosis of hydatid mole is made, the uterus should be evacuated promptly because the fetus has already perished, the bleeding is often dangerous, the uterus may be perforated by the eroding mole and a chorion epithelioma may result.

Missed Abortion.—During the early months of a missed abortion immediate therapeutic abortion is seldom required. Delay is often necessary to establish a positive diagnosis, but when the condition is prolonged and the uterus makes no attempt to empty itself, dangers of hemorrhage, anemia, invalidism and even death may make artificial emptying of the uterus advisable.

Renal Insufficiency.—When a chronic nephritis is present, accompanied by marked renal insufficiency, it is useless to delay on account of the child because of the great danger to the mother.

Acute Hydramnios.—This complication occurring in the fourth or fifth month is not only an exceedingly painful condition, but for the preservation of the patient's life immediate evacuation of the uterus is required.

Toxic Chorea.—Nearly all choreas of pregnancy are of the ordinary Sydenham type, requiring only careful neurological management. There are a few, however, of definitely toxic origin which will not respond to the usual treatment, and endanger the mother's life. In these cases abortion is clearly indicated. (See Chapter XXIX.)

Conditions Occasionally Requiring Therapeutic Abortion.—*Tuberculosis.*—Pulmonary tuberculosis was formerly considered a definite reason for therapeutic abortion in nearly all stages of the disease. Modern management and clinical experience have continually reduced the indications until now many believe that tuberculosis is not an indication for evacuation of the uterus and all have limited the necessity to a very few cases. Nearly everyone now agrees that the treatment of the disease is the important thing.

Heart Lesions.—These, like tuberculosis, have a constantly narrowing indication, the emphasis being placed upon proper management of the cardiac situation rather than upon abortion.

Uterine Hemorrhage.—This symptom is, as a rule, an indication of threatened abortion, but may be due to placenta praevia or other separation of the placenta. If the bleeding be uncontrollable or if the percentage of hemoglobin steadily falls, abortion may be required.

Incarcerated Retroversion of the Uterus.—In this condition the uterus will

rarely require emptying. Nearly all apparently imprisoned uteri are spontaneously released, or may be manually set free. When, however, the incarceration is definite, a laparotomy to relieve it is preferable to induced abortion in order that the pregnancy may be preserved. Only when bleeding is so profuse that there is little chance of saving the child is abortion justifiable.

Methods.—*Early and Intermediate Abortion.*—If the cervix is easily dilatable it may be divulsed with metal dilators until one finger can be introduced and the ovum separated and removed. (See Treatment of Inevitable Abortion.)

When haste is necessary, the best method is vaginal hysterotomy (vaginal cesarean section).

If sterilization be advisable the uterus may be emptied by abdominal hysterotomy ("miniature cesarean section"), when a permanent or temporary sterilizating operation may be done.

Late Abortion.—The methods to be employed in inducing abortion during the late period are the same as in the induction of premature labor. (See Chapter XLI.)

MISSED ABORTION

"Missed abortion," the failure to abort at the usual time after the death of the embryo, or fetus, is too generally considered a rare and unimportant condition while, in fact, it is a frequent occurrence and often results in chronic invalidism, sometimes of a very serious nature. In this country it is a much neglected subject. Most text-books dismiss it with a paragraph and American medical literature contains less than ten articles that are worth the reading, while European literature is rich with nearly 200 references on this important subject—important because of its menace to health and life and because it happens frequently enough to occur in the practice of nearly every physician, if he were able to recognize it.

Origin of the Term "Missed Abortion."—The term was first applied by Matthews Duncan[17] who doubtless got his idea from Oldham[51] who, in 1847, coined the term "missed labor." Recognizing the similarity of the condition of a fetus, dead before viability, with no effort at expulsion, he quite logically used the terms "missed abortion" and "missed miscarriage." The latter term has become obsolete; "missed abortion" is now applied to all cases of retention of the ovum beyond the usual time of expulsion after its death. What is the usual interval between these two events? Rhodes[63] says: "The fetus is usually aborted a few days after death," which the author thinks ordinarily is not true. Seitz[75] is nearer right, when he puts it any time up to four or five weeks.

Litzenberg,[39] in 1920, placed an arbitrary limit of two months after the death of the fetus as the borderline between abortion and missed abortion because constitutional symptoms are rare in the early stages of missed abortion and pathologic conditions begin to manifest themselves about the eighth week. That this arbitrary demarcation, based upon clinical evidence, was not far wrong, is shown by Streeter[76] who says: "Among our records are 437 cases of retention of the dead fetus, for which there were reliable histories of the menstrual age. Retention was calculated on the basis that the discrepancy between the menstrual age and age according to size (Carnegie Curve of Growth) represents the approximate lapse of time between the death of

the fetus and the time of its expulsion. In this way it was learned that the dead fetus is ordinarily retained about six weeks, the retention being somewhat shorter in the earlier, and somewhat longer in the later weeks. In exceptional cases retention may be very greatly prolonged (missed abortion)."

Etiology.—We are here not concerned with primary causes of the death of the fetus, but only with the etiology of the retention. This must be considered from two standpoints: First, why is the abortion missed? Second, What are the causes of the expulsion after the uterus has lain dormant so long? Lack of irritability of the uterus, which was first suggested by von Graefe[85] is thought of at once—but why does it not respond to the irritation of the dead foreign body within it? Liepmann[33] attributes it to central lesions, but this will explain only the occasional case.

Leopold,[37] Stanley Warren,[86] Menzies,[47] Mueller,[49] Playfair,[58] Beigel,[7] E. Fraenkel,[19] Sänger,[72] Rissman,[64] Arthur,[4] gave theories enumerating most pelvic lesions from thin musculature of the uterus to atresia and stenosis of the cervix. Most of the suggestions were more or less fantastic and their variety and number only emphasize our ignorance of the cause of the retention.

Why does the secondary abortion occur? Why should a uterus, which has been dormant for weeks and months, suddenly expel its contents, often with contractions of the greatest violence? The foreign body theory of Orloff[55] and Ivanoff[32] is not sufficient, for the foreign body has been present all the time.

The theory of pressure on the internal os and paracervical ganglia is reasonable, but the theory of Ernst Fraenkel[19] that the returning menstrual function, with its consequent congestion, causes the bleeding and contractions is more tenable. Only the theory of Fraenkel[19] even hints at a possible hormonal cause.

Inasmuch as all the normal phenomena of reproductive life are controlled by the endocrines, it would seem much more logical to theorize that disturbances of hormonal control may be the determining etiologic factors. In this connection Rongy and Arluck[67] said: "In the near future such conditions will definitely be explained as due to some derangement of the endocrine system." With all the progress in endocrinology and in spite of, or perhaps because of, the confusion caused by research upsetting research, the greatest hope of a solution lies in this field.

Incidence.—Missed abortion undoubtedly occurs much more frequently than is generally supposed. Up to 1896 von Graefe[85] had collected 70 cases and Ernst Fraenkel,[19] in 1903, brought the collected cases up to 105. Both Williams[89] and DeLee[15] agree that it is not an uncommon condition. The author of this chapter has personally seen 23 cases which, occurring in one limited experience, would not indicate a very great rarity. The condition, according to most published reports, is more common in multiparae, but in the author's experience a majority occurred in the first pregnancy. The condition may even recur in the same patient (Machenhauer[42] and Litzenberg[39]).

Medicolegal Significance.—Unjust suspicion may rest upon a married woman, who, in the absence of her husband, expels a fetus corresponding in development to a shorter time than the husband's absence, which could very easily be the case in the event of a missed abortion. Duncan,[17] commenting

on this point, said: "Such unfortunate misapprehensions have happened to women in the condition of missed abortion, which shows the importance of counting the term of a woman's pregnancy not up to the time the fetus was discharged, but back to the time when it died."

Termination.—Ultimately the ovum is usually expelled, but it may be retained for months and even years. One case of retention for twenty-eight years and another for fifty-two years, found at autopsy, have been reported. The usual termination is maceration with toxemia. Mummification sometimes occurs and, exceptionally, the ovum may become infiltrated with calcium salts, resulting in an intra-uterine lithopedion. Decomposition is common, but putrefaction is rare. Although infection is infrequent, an unrecognized missed abortion is sometimes brought to light by the appearance of an inexplicable sepsis months after the death of the fetus.

Polano[61] and Ludwig Fraenkel assert the possibility of complete resorption of the entire ovum. The author has seen several cases with the entire disappearance of the embryo in an otherwise intact ovum (Fig. 512). Absorption cannot take place after the tenth or twelfth week (Edgar). Skeletonization is a termination in which only the bones of the fetus are found within the uterus (Rosenkranz[63]). Only 10 cases are reported in the literature, up to 1928.

Pathology.—Bleeding may be absent but is a frequent finding, giving the ovum the appearance of a hematoma mole. In the placenta infarcts are numerous, sometimes occupying nearly the whole organ, suggesting the probable cause of death of the fetus. Degeneration of various kinds and grades is the rule. Ohlbaum[53] found fatty degeneration of the entire ovum. The placenta is usually hard, dry, shrivelled, tough, of a red or whitish-yellow, or waxy appearance. Logically, the longer the retention, the greater and more varied are the manifestations of degeneration. When the fetal circulation is interrupted there occurs a thickening of the blood vessel intima, gradually obliterating the fetal intravillous blood vessels. The epithelium of the villi atrophies because it is robbed of its nourishment. The chorion epithelium may, however, be nourished for a time by the maternal intervillous circulation, delaying the degenerative process, which is largely hyaline. Calcium deposits occur first in the surrounding fibrin layer, later involving the tissues within the villi. One of the great dangers of missed abortion is degeneration of the uterine blood vessels and the neighboring wall, which may be so completely destroyed that uncontrollable hemorrhage results (Rosenstein[69]).

The amount of amniotic fluid present depends upon the age of the ovum at death and the length of time it has been retained in the uterus. Disappearance or marked diminution of the amniotic fluid without rupture of the membranes is the rule. Occasionally a dropsical ovum is observed (Seitz[75]). In cases of retention for any considerable length of time, a deposit of connective tissue is nearly always found, which may be in an amount sufficient to be called sclerosis of the placenta (Garrigues, Rosenstein[69]).

There is frequently a discrepancy between the size of the placenta and the age of the fetus, the former being often as large as the placenta of a fetus a month or more older than the one found. This is due to connective tissue increase, hemorrhages into the placenta and the curious true growth of the placenta after the death of the fetus. When the fetus dies, especially in the early weeks, the chorion and decidua may go on growing because they are

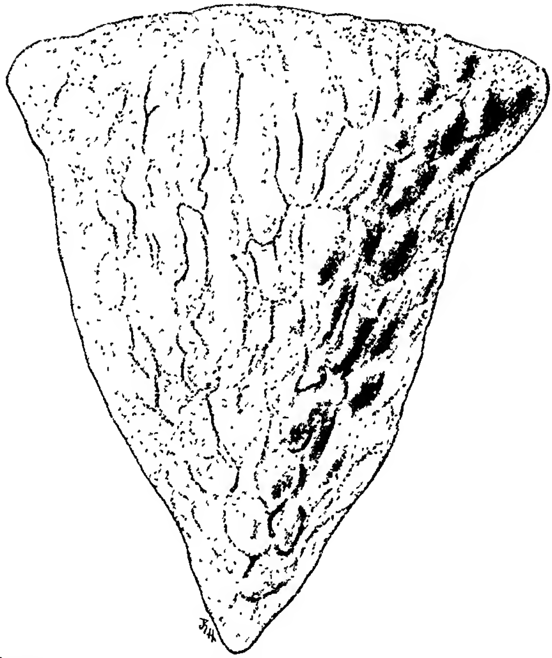

Fig. 511.—Missed abortion. A two months' pregnancy retained in the uterus thirteen months showing a complete decidual cast of the uterus. (Author's case.)

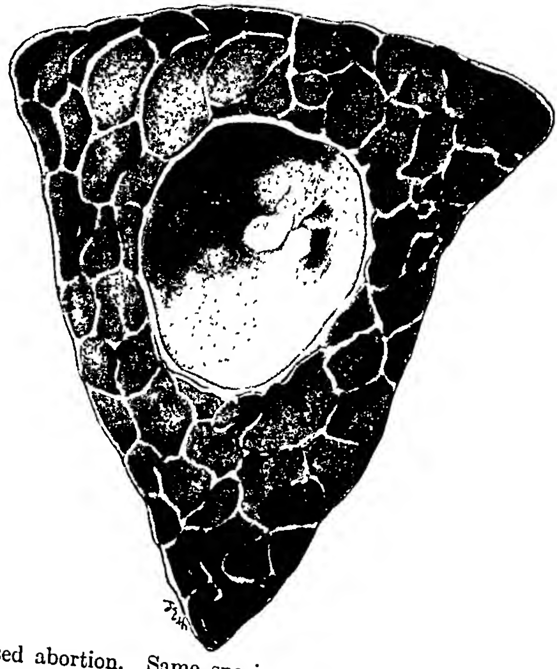

Fig. 512.—Missed abortion. Same specimen as in Fig. 511 cut in coronal section showing the amniotic cavity with remnant of the umbilical cord. The embryo has been completely absorbed, being represented only by the clubbing at the end of the cord. No amniotic fluid was present.

nourished by the maternal blood circulating in the intervillous spaces, which may continue for a long time. LaVerge[36] observed karyokinesis, indicating cell multiplication rather than hypertrophy. The Langhans or inner layer of the villous epithelium, which is not in direct contact with maternal blood, undergoes early coagulation necrosis; but the outer syncytial layer, bathed in maternal blood, is preserved much longer, until thrombosis takes place, shutting off the blood supply to the intervillous spaces.

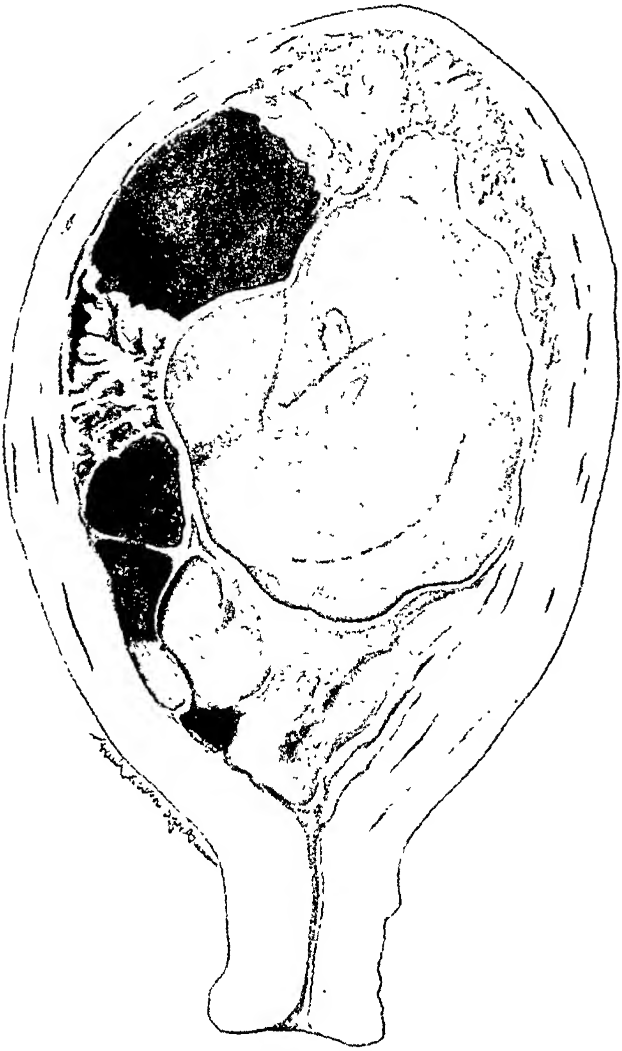

Fig. 513.—Missed abortion showing retention of the complete ovum with soft parts of the fetus almost entirely absorbed. "Skeletonization" is nearly complete. (After Bumm.)

In the second half of pregnancy von Franqué asserts that the phenomenon of continued growth, after the death of the fetus, does not occur. That the placenta lives and grows, at least in the early months after the death of the fetus, has been proved by Mall,[44] Physalix,[57] Giocomini,[24] and LaVerge.[36]

Microscopical studies show all stages of necrosis and degeneration of tissues, placenta, decidua, amnion, blood vessels, the fetus and even uterine walls. The villi have almost no vessels and thrombosis rarely occurs. The stroma of the villi is fibrotic everywhere and in varying stages of hyaline

degeneration. We also see scattered calcium deposits, fat infiltration in low-grade lipoid degeneration and here and there glycogen from the decidua. If the ovum remains in the uterus for a long time, drying out or mummification occurs. Small areas of hydatidiform degeneration of the villi are occasionally found; Thelin[79] reported two of his own and collected seventeen others, which influenced him to advocate active treatment of all cases of missed abortion because he feared the development of chorion epithelioma when the mole remained as long in the uterus as it does in missed abortion. As yet, however, no such catastrophe has been reported. The hydatid changes are

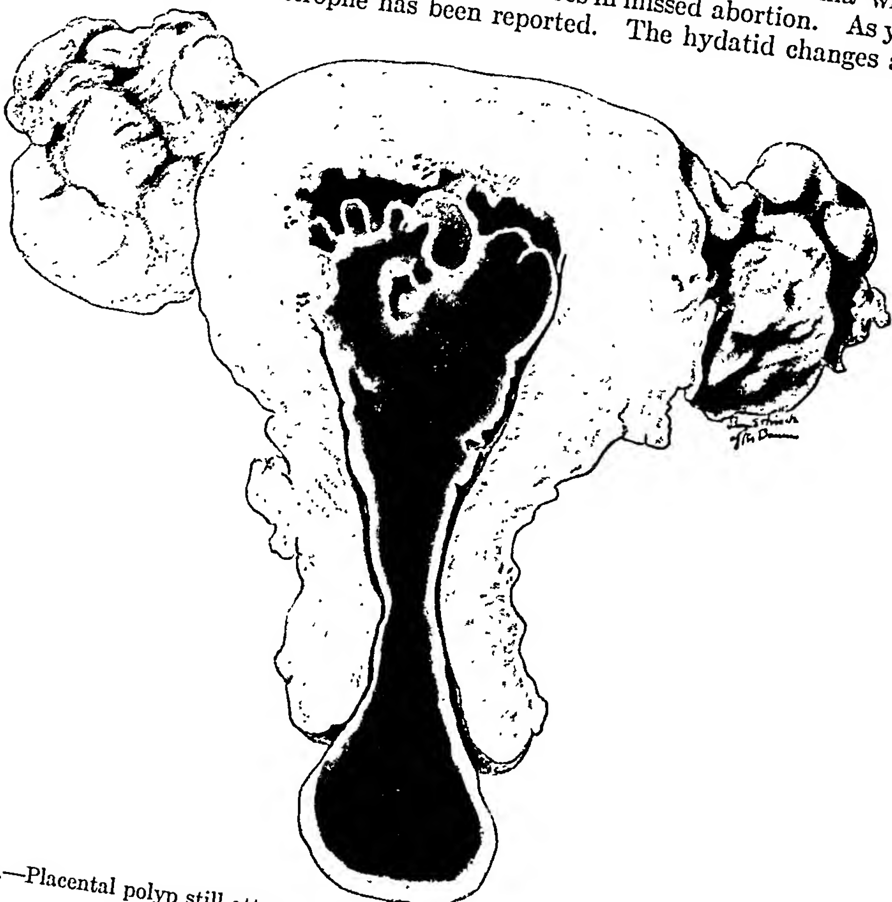

Fig. 514.—Placental polyp still attached to placental site and protruding from the cervix. (After Bumm.)

usually not extensive and are rather of the beginning type of degeneration (Doerffel[16]).

Symptoms.—Usually, but not always, after the death of the fetus there are signs of an abortion, which subside, the patient thinking that a threatened abortion has been avoided or completed. Weeks or months later the physician is consulted because there is no increase or an actual decrease in the size of the uterus, on account of continued hemorrhage, or the cessation of fetal movements and other subjective signs of pregnancy. Examination shows that the uterus has not grown, or that it has even decreased in size. Its con-

sistency has not that characteristic elastic softness, peculiar to normal pregnancy, neither is it hard, like a fibroid, but rather between the two. Regressive changes in the breasts also take place. The patient often mistakes the occasional hemorrhages for irregular menstruation. She seeks the advice of her physician because of her unaccountable increasing invalidism, which begins usually with malaise, anorexia, or headache, followed by loss of weight, chilliness, a foul taste in the mouth, a bearing-down weight "like a stone in the abdomen." All of these symptoms increase until the patient is, indeed,

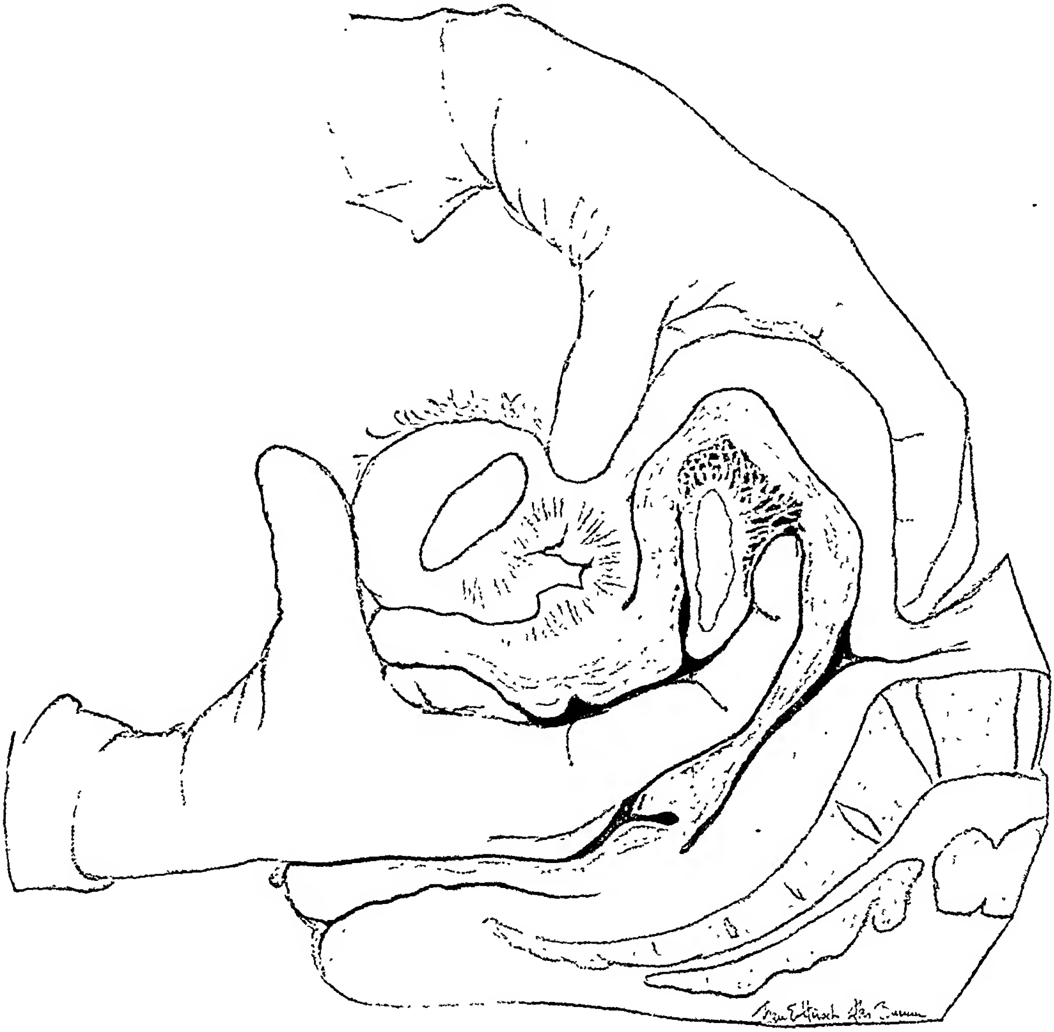

Fig. 515.—Manual separation of the ovum. Illustrating method of detaching the ovum from the uterus. (After Bumm).

an invalid with an afternoon fever and a victim of grave anemia out of all proportion to her loss of blood. In some cases symptoms of mental derangement appear. Hemorrhage, in some form or other, is usually an accompaniment of missed abortion, but is an inconstant and confusing symptom, and on the other hand the bleeding may constitute a very grave danger. Upon examination or other manipulation or at the time of expulsion there may be a violent hemorrhage, or no bleeding at all. Duncan[17] reported the loss of a quart of blood following the introduction of a tent. Bleeding at the

at the desired angle by a ratchet-controlled cogwheel. White states his principle of drainage thus:

"In a few hours after delivery, as soon as the patient has had a little rest, she should sit up in bed with a bed-gown thrown over her shoulders. . . . This frequent upright posture is of the utmost consequence, and cannot be too much enforced. It prevents the lochia from stagnating, the stools and urine from being too long retained, and promotes the contraction of the uterus together with that of the abdominal muscles."

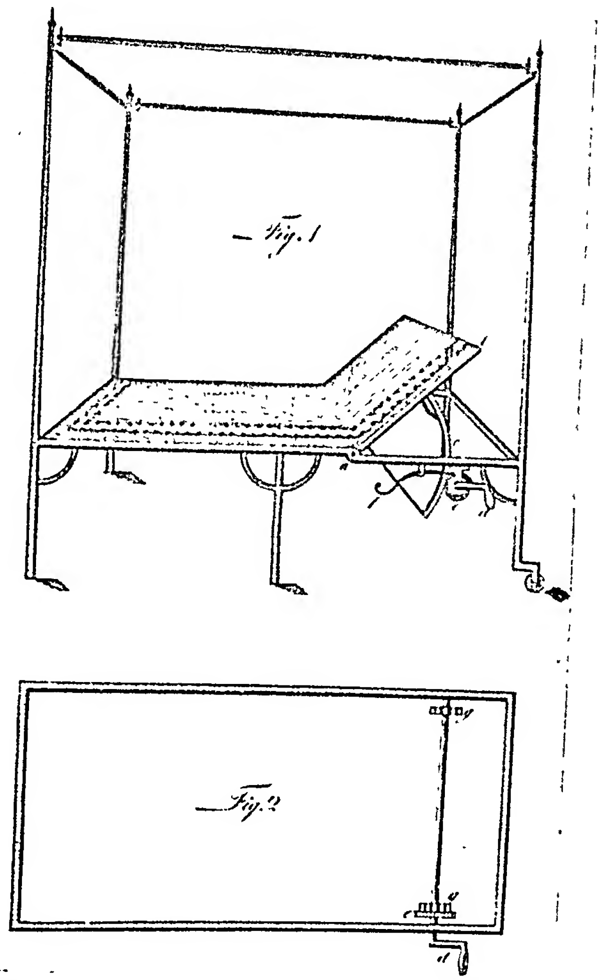

Fig. 48.—Bed with adjustable back-rest. From the plate accompanying the *Treatise* by Charles White, London, 1773.

"If the discharge of the lochia be moderate, the patient should not only sit up often, but should every day get out of bed staying up as long as she can without fatigue, and continuing it a little longer every day than she had done the day before."

To continue drainage he had constructed a chair similar in practically all details to the modern "Morris" chair (Fig. 49). This chair was provided with a back which could be raised or lowered at will and with a hinged foot-rest. The patient could be placed in a horizontal position if necessity arose.

The success of this posture as a postpartum prophylactic procedure was so striking, in the practice of White and in that of his students and colleagues, that he was able to say:

Among other pioneer principles laid down by White should be mentioned the first clear-cut statement in any text on midwifery of the necessity of absolute cleanliness in the lying-in chamber, the isolation of infected patients, and adequate ventilation. With some amplification the following statement might well describe modern procedure:

"The lying-in chamber to be in every respect as sweet, as clean, and as free from any disagreeable smell as any other part of the house. . . . The room is to be brushed every day, and the carpets taken out to be cleaned and aired. . . . The patient is to be often supplied with clean linen, and clean well-aired sheets are to be laid upon the bed. . . . The windows are to be opened . . . no board or other contrivance to block up the chimney, the curtains not to be closely drawn. . . . In hospitals, if separate apartments cannot be allowed to every patient, at least as soon as the fever has seized one she ought immediately to be moved into another room, not only for her immediate safety, but for that of the other patients. Or it would be still better if every woman was delivered in a separate ward and was to remain there for a week or ten days, until all danger of this fever was over."

It is well to recall this citation from White's treatise in connection with the utter indifference to sanitary conditions set forth in the initial *Lehre* of Semmelweis.

The first edition of White's treatise appeared in 1773. It was translated into French and published in Paris in 1774; a German translation appeared in Leipzig in 1775. There were three later English editions,[1] and one American which was published in 1793.[2] It will thus be seen that White's teachings were given wide circulation. He must be remembered not only for the principle of pelvic drainage (White's position), but for his insistence upon the resorption character of puerperal fever. Among obstetricians he is deserving of remembrance for his advocacy of the delivery of the shoulders by the force of uterine contraction, and for his insistence that the circulation in the cord shall cease before severance. White was also a great surgeon, the principal founder of the Royal Infirmary of Manchester, and of what is today St. Mary's Lying-in Hospital of that city. He was the foremost teacher of midwifery in the north of England. Writing in 1801 he says:[3]

"For the last ten years the author has been *Man-midwife extraordinary to the Manchester Lying-in Hospital and Charity for delivering poor married women at their own habitations*, during which time, there have been delivered under that institution 8000 women. Previous to that time, he was surgeon to the Manchester Infirmary thirty-eight years. He thinks therefore he may safely say, though there may be many men who have attended more women in natural labours, yet there are none, now living, who have attended so many difficult cases of parturition, and of diseases in consequence of it."

[1] The second edition appeared in 1777, the third in 1784, the fifth in 1791. Cullingworth (loc. cit.) calls attention to the fact that no fourth edition can be traced. Apparently the words "fifth edition" on the 1791 volume should read "fourth edition."

[2] Worcester, Massachusetts.

[3] White first described what John Hull (1761–1843) later termed "phlegmatia dolens" in an essay entitled *An Inquiry into the Nature and Cause of that Swelling, in one or both of the Lower Extremities, which sometimes happens to Lying-in Women*, published at Warrington in 1784; a second edition appeared in 1792, and a supplementary essay under the same title appeared at Manchester in 1801. In this latter essay White notes that "cases of *Phlegmatia alba dolens Puerperarum*" occurred less frequently than had been generally imagined, and quotes Dr. Robert Bland (1730–1816) of the Westminster General Dispensary as reporting five cases in 1897 deliveries. In his own experience out of 8000 women delivered at the Manchester Lying-in Hospital, and at their own habitations, only four were so afflicted.

several doctrines or principles, well-nigh modern in conception. He notes that if coagulated blood be retained within the uterus, it will communicate an inflammation to the uterus when it begins to putrefy. The symptoms of inflammation will then appear from the absorption of this "very active poison." He says:

". . . . does not this analogy hold good, when the puerperal fever is owing to putrid effluvia being taken into the habit by the absorbents *ab extra?*"

He further notes that should a man be seized with a putrid fever originating from a wound, the wound itself may show no sign of inflammation, but there has occurred an absorption which has brought on the fever. Hence he concludes that in puerperal fever the uterus may sometimes have a healthy appearance because it is not the principal seat of the disease. He quotes Peu[1] to the effect that

". . . . putrid *effluvia* exhaling from wounded men, brought on a fever, which killed a great many child-bed women, who lay in the same hospital. . . ."

His next remark should be recalled when we consider the *Lehre* of Semmelweis:

". . . . and are not the putrid *effluvia*, arising from the lochial discharge, in lying-in hospitals, capable of producing the same disease?"

In another paragraph he warns that symptoms must not be considered the disease and lays down the first clear pronouncement that fever is not a disease:

"We ought always to make a distinction betwixt the fever and the disease, which may readily be done, by the practice of joining the epithet expressive of the nature of the disorder, instead of the situation of the patient. We are to remember, when we are talking of a fever, that we are only talking of a symptom or a combination of symptoms, which may afford us no more insight in regard to the original cause of an inflamed leg, if we were only to know, that the leg was hot and painful, and that the patient had a fever, and a quick pulse.

"We are to discover the cause, not by reasoning and conjecture, but by certain facts which happened previous to it, or at the onset of the patient's illness."

The following indicates that Kirkland possessed a fairly accurate conception of pyemia:

"Suppose we find the uterus free from mortification, or the appearance of a diseased state, it does not follow, that it has not been concerned in bringing on the appearances we meet with in opening the dead body. Are not suppurations in the chest and in the abdomen, often the consequence of the inflammation following amputated limbs, . . . Yet after death, there having been a discharge, the sore looks pale, and has not the least appearance of having been instrumental to so much injury."

But few writers who followed Kirkland accepted his clear-cut statement that fever is a symptom. Among those who accepted his idea or arrived at the same conclusion independently were **Edward Foster** (d. 1780) and **Philip Pitt Walsh** (d. 1787). Foster considered "puerperal fever" an improper term, inasmuch, he says,

[1] *La Pratique des Accouchements*, Paris, 1694, lib. II, chap. I, sec. III.

"In the year 1760 (which is about eleven years after the first institution of Lying-in Hospitals in England), the puerperal fever was epidemical in London. From the 12th of June, till the end of December Dr. Leake informs us,[1] that twenty-four women died of it in the British Lying-in Hospital." . . .

"In the year 1773, the puerperal fever appeared in the lying-in ward of the Royal Infirmary of Edinburgh, of which the late Professor Young gives the following account: It began about the end of February, when almost every woman, as soon as she was delivered, or perhaps about twenty-four hours after, was seized with it; and all of them died, though every method was used to cure the disorder. This disease did not exist in the town. I found that the women in the lying-in ward did not recover so well last year as formerly; but scarcely any died. It was this made me think there was a local infection, and determined me to shut up the ward till it could be removed. This I did, after losing six women."[2]

And John Clarke himself says:

"If the disease should occur in an hospital, the patient should be immediately removed from all others, and the bed, bed-clothes, &c. should be all washed and aired before they be again employed, or destroyed, and the wards should be scoured, painted, and white-washed. This was the practice in the General Lying-in Hospital in Store-Street, after both the epidemics. I mention this circumstance, because Dr. Joseph Clarke expresses his surprise that it has not been done in England. It may have, and probably has been done in other Hospitals, because it is agreeable to the dictates of common sense, that nothing is so likely to prevent the progress of infection as giving new surfaces, or cleaning old ones."

John Armstrong[3] in his *Facts and Observations relative to the Fever Commonly called Puerperal*[4] strongly emphasizes the necessity for cleanliness and ventilation of the lying-in chamber. He notes that the apartment of the lying-in woman must be carefully cleaned and ventilated before confinement, nurses and other persons known to have been with those who may have been affected are not to go near or have any contact with the lying-in woman, and the obstetrician is to pay the most scrupulous regard to the cleanliness of his own person, using daily ablutions of the whole body and frequent changes of linen and dress. He says no harm can arise from these precautions.

Alexander Gordon (1752–1799).—No epidemiological study relative to puerperal fever had been promulgated until the publication of Alexander Gordon's[5] *Treatise on the Epidemic Puerperal Fever of Aberdeen* (Fig. 51) in

[1] *Practical Observations on Child-bed Fever*, London, 1774.

[2] Dr. Young, no doubt following earlier attempts to disinfect ships (*An essay on the most effectual means of preserving the Health of Seamen in the Royal Navy (antiseptic sprinklings, aromatic fumes)* by J. Lind, London, 1757), proceeded to close the lying-in ward, ordered it washed and painted, caused gun-powder to be ignited and the windows and doors kept open during the daytime. After two weeks of this treatment, the ward was reopened whereupon puerperal fever again reappeared.

[3] John Armstrong received his M. D. from Edinburgh in 1807. He was physician to the Sunderland Infirmary for a time and in 1818 moved to London. For five years, 1819–1824, he served as physician to the London Fever Institution.

[4] London, 1814.

[5] Alexander Gordon was born in 1752 in Milltown of Drum, Peterculter, Aberdeenshire. After completing the usual course of general education and taking the degree of M. A. at Marischal College, he began the study of medicine, which he pursued at Aberdeen Infirmary and the University of Edinburgh. Receiving testimonial letters from the Corporation of Surgeons in London, he entered the Royal Navy as Surgeon's mate in 1780, and in 1782 was advanced to the rank of Surgeon. Three years afterward, being placed on half-pay, he repaired to London, and became a resident pupil of the Lying-in Hospital in Store street, then under the care of Dr. Edward Ford (1746–1809), attending at the same time the joint lectures on midwifery of Drs. Denman and Osborn. He subsequently became a pupil at the Middlesex Lying-in Dispensary, under Dr. Andrew Thynne (d. 1813),

". . . erysipelas was epidemic, almost every person, admitted into the hospital of this place, with a wound, was, soon after his admission, seized with erysipelas in the vicinity of the wound. The same consequence followed the operations of surgery; and the cause is obvious; for the infectious matter, which produces erysipelas, was, at that time, readily absorbed by the lymphatics, which were then open to receive it.

"Just so with respect to the Puerperal Fever; women escape it till after delivery, for, till that time, there is no inlet open to receive the infectious matter which produces the disease. But after delivery, the matter is readily and copiously admitted by the numerous patulous orifices, which are open to imbibe it, by the separation of the placenta from the uterus."

In Chapter IV, Gordon cites his proof that puerperal fever is not due to a noxious constitution of the atmosphere:

"That the cause of this disease was a specific contagion, or infection, I have unquestionable proof. . . .

"For this disease seized such women only, as were visited, or delivered by a practitioner, or taken care of by a nurse, who had previously attended patients affected with the disease.

"In short, I had evident proofs of its infectious nature, and that the infection was as readily communicated as that of the smallpox, or measles, and operated more speedily than any other infection, with which I am acquainted.

"With respect to the physical qualities of the infection, I have not been able to make any discovery; but I had evident proofs that every person, who had been with a patient in the puerperal fever, became charged with an atmosphere of infection which was communicated to every pregnant woman, who happened to come within its sphere. This is not an assertion, but a fact, admitting of demonstration, as may be seen by a perusal of the foregoing table."

And here in a few lines from Gordon is the entire etiology of Semmelweis, lacking only specific mention of the examining finger.

"If in the dissection of a putrid body, a surgeon scratch his finger, the part festers, that is, inflames and suppurates; and if a fever should be the consequence, it is inflammatory in the beginning. In like manner, if putrid matter be applied to the uterus, it inflames that organ and the contiguous viscera; that is it gives rise to the puerperal fever, which is ushered in with a cold stage, and succeeded by a very rapid pulse and acute pain in the abdomen."

Thomas Denman had been appointed in 1769 physician midwife to the Middlesex Hospital, and was the first licentiate in midwifery of the College of Physicians. Although he had written on puerperal fever, it was not until the second edition of his *Introduction to the Practice of Midwifery* (1801) that he added this significant paragraph in which he announced the contagiousness of puerperal fever as proved.

"There is another consequence of an epidemic, or even a sporadic puerperal fever, on which it would be criminal to be silent. This is the contagious nature of these fevers; it having been long suspected, and being now *fully proved*, that they may be, and often have been conveyed by midwives or nurses, from one patient to another. This fact explains the reason, why persons, practising for many years with the most enviable success have at one or more periods of their lives, without any change in the principles or manner of their practice, met with a number of unfortunate cases; when perhaps an adjoining neighbourhood has been entirely free from such diseases. Of this I have known many instances which could be exactly traced, and have repeatedly seen it the cause of the most painful distress, and severest reflections, in my own practice."[1]

[1] Fasbender states (*Geschichte der Geburtshülfe*, Jena, 1906) that he is unable to find this statement in Denman.

presence of erysipelas in the hospitals followed by puerperal infection. In the decade 1830 to 1840 numerous articles are found in the *Edinburgh Medical and Surgical Journal*, the *Provincial Medical and Surgical Journal*, the *London Medical Gazette*, and the *Northern Journal of Medicine*—all dealing with the similarity and coexistence of puerperal fever and erysipelas. Léon Clément Voillemier[1] (1809–1878) in his account[2] of the Paris epidemic of puerperal fever of 1838 calls the disease "the pyogenic fever of lying-in women."

Robert Ceely[3] (1797–1880) of Aylesbury notes[4] that in the Aylesbury epidemic in the autumn of 1831

". . . puerperal disease was erysipelas of the mucous membrane of the vagina and uterus, extending into the abdomen through the Fallopian tubes, and from them by contiguity and continuity of surface to the parts above described. . . .

"That puerperal fever and erysipelas have a common origin; that the puerperal disease, and the prevailing erysipelas, were identical, and each capable of producing the other, was soon beyond a doubt; every puerperal case giving rise to numerous cases of the common epidemic, in the persons of the nurse and attendants."

Thomas Nunneley[5] (1809–1870) of Leeds in his treatise on erysipelas[6] considers that puerperal fever and erysipelas have a common origin. In his chapter devoted to puerperal fever he notes that the symptoms of the two diseases are similar; that the postmortem appearances are in many points identical; that both diseases may and frequently do prevail at the same time, and that one may be propagated from the other. He quotes Jean Cruveilhier (1791–1873) to the effect that the situation of the internal surface of the uterus following delivery is exactly similar to that of an amputation wound which he says

". . . would lead one to expect that erysipelas, so common in latter instances, would not be rare in the former."

A great mass of clinical evidence as to the infectious character of puerperal fever may be noted in the literature of the period. Among the writers on the subject may be mentioned John Leake,[7] Nathaniel Hulme[8] (1732–1807), Alexander Butter,[9] Robert Gooch[10] (1784–1830), James Blundell[11] (1790–

[1] Léon Clément Voillemier became an interne in the Paris hospitals in 1837, received his degree in 1842 and shortly afterwards became surgeon of the hospitals.

[2] *Histoire de la fièvre puerpérale ou fièvre pyogénique observée en 1838 à l'hôp. de la Clinique*, Paris, 1839.

[3] Robert Ceely studied at the London Hospital, Guy's Hospital and in Edinburgh; became a member of the Royal College of Surgeons of England and was licensed by the Apothecaries' Society of London in 1819. Especially distinguished for his contributions to the natural history of vaccinia. In 1835 he published *An account of contagious epidemic puerperal fever.*

[4] *Lancet*, London, March 7, 1835.

[5] Thomas Nunneley, surgeon to the Leeds General Infirmary, was one of the earliest writers to advocate the use of tincture of iodine in the treatment of cutaneous erysipelas. He used a tincture of forty grains of iodine to an ounce of alcohol applied to the skin surface with a camel's hair brush.

[6] *A Treatise on the Nature, Causes, and treatment of erysipelas*, London, 1841.

[7] *Practical Observations on the Child-Bed Fever:* etc., London, 1772.

[8] *A Treatise on the Puerperal Fever*, London, 1772.

[9] *An Account of Puerperal Fevers*, etc., London, 1775

[10] *An Account of some of the most important diseases peculiar to women*, London, 1829.

[11] *Lectures on Midwifery, and the diseases of women and children; as delivered at Guy's Hospital*, London, 1832.

James Blundell[1] in his midwifery lectures delivered at Guy's Hospital interdicts surgical operations in hospitals during the presence of puerperal fever. He cites three cases in which minor operations on the vulva resulted in peritonitis.

In a letter to Robert Lee,[2] **William Campbell** states that in October, 1821, he assisted at the postmortem examination of a woman who had died of puerperal fever. Certain specimens from this case were carried by Dr. Campbell in his coat pocket and that same evening without changing his clothes he attended a case of confinement. The next morning in the same clothes he assisted one of his pupils in a delivery. During the next three weeks he had five deaths from puerperal fever. He records that in June, 1823, he assisted one of his pupils at another postmortem; that following the examination he was unable to wash his hands as he should have done and finding that two patients required his immediate assistance, he attended them

> ". . . . without further ablution of my hands, or changing my clothes, and both of them were seized with the disease and died."

He says that since that time he has avoided assisting in postmortem examinations.

The Fothergillian gold medal was awarded in 1836 by the Medical Society of London to **George Moore** for his essay on puerperal fever. In this Moore cites the experiment performed by Leuret in which he injected blood from a living horse infected with *pustule maligne* into the veins of a healthy mare five months with foal. The mare died five days afterward and the heart, lungs, and intestines were found to be studded with dark ecchymoses and the uterus was gangrenous. He also notes a striking pronouncement made by **Charles Waller**,[3] obstetrical physician and lecturer on midwifery at St. Thomas's Hospital. He says:

> "Dr. Waller thinks it not unlikely that it is communicated only by those persons who have occasion to touch the pudenda of the patient."

[1] James Blundell studied at the United Borough Hospitals under his uncle Dr. John Haighton (1755–1823), a well-known physiologist. He graduated M. D. at Edinburgh on June 24, 1813. The following year he began to lecture in London in conjunction with his uncle on midwifery and later on physiology. He succeeded Haighton as lecturer at Guy's Hospital, and for many years had the largest class on midwifery in London. He published *Principles and Practice of Obstetricy, with Notes* (1834), and *Observations on some of the more important Diseases of Women* (1837).

[2] *Dr. Campbell on Puerperal Fever, London Medical Gazette*, vol. ix, 1832.

[3] Charles Waller, M. D., M. R. C. P., was born at Guildford. He pursued his medical studies at Guy's and St. Thomas's Hospitals, where he distinguished himself as a diligent student, and began practice, at the age of twenty-three, in Aldersgate-street. He early directed his attention to the obstetrical branch of medicine, and commenced delivering a course of midwifery lectures at his own residence. At the same time he, in connection with Mr. Doubleday, established a Maternity Charity, which enabled him to supply his pupils with clinical instruction. His first publication, a little work entitled *Outlines of Midwifery*, appeared during his career as a private lecturer. It was a favorite with the students, and ran through several editions. On the establishment of chairs of midwifery in the medical schools, Dr. Waller became connected, as lecturer on that subject, with the Aldersgate-street school. Subsequently he was invited to assist Dr. Cape as assistant-physician-accoucheur and lecturer on midwifery at St. Thomas's Hospital. On the resignation of Dr. Cape he was appointed to the full chair, and was elected physician-accoucheur to the hospital. These appointments he retained at the time of his death.

Dijon. The use of chlorine gas as a disinfecting agent was advocated by Antoine François de Fourcroy (1755–1809) in 1791, and soon after employed by Cruickshank[1] of Woolwich, and Michael Faraday (1791–1867); the latter it will be remembered liquefied chlorine in Sir Humphrey Davy's (1788–1829) laboratory (1823). Faraday's disinfection of the Milbank penitentiary with chlorine was considered a veritable achievement. From the time of Morveau, chlorine had been used as a disinfectant rather widely in the British navy as related by Augustus B. Granville[2] (1783–1871).

Fig. 52.—Antoine Germaine Labarraque. (Courtesy of the New York Academy of Medicine.)

The discovery of the value of the use of chlorine as a surgical disinfectant was incidental to the need which arose of providing some means of rendering the occupation of the French catgut maker less objectionable. The prize offered by the Society for the Encouragement of National Industry of France in 1819 was awarded to **Antoine Germaine Labarraque**[3] (Fig. 52) (1777–1850), an apothecary, for a solution containing chlorine, which was found to destroy odors. It should be recalled that in the minds of most

[1] Many bibliographers have confused William Cruickshank of Woolwich with William Cruikshank (1745–1800), the anatomist and teacher in the Windmill Street School, London, founded by Dr. William Hunter. Cruickshank was an artillery surgeon and was probably attached to the Ordnance laboratory which in 1795 was moved from Greenwich to Woolwich. Woolwich is now a S. E. metropolitan borough of London. Many papers on electricity appeared from the pen of William Cruickshank of Woolwich and he devised a galvanic trough composed of serially connected cells.

[2] *Autobiography.* Edited by his youngest daughter, Paulina B. Granville, London, 1874.

[3] Antoine Germaine Labarraque was the author of *Manière de se servir du chlorure d'oxyde de sodium, soit pour panser les plaies de mauvaise nature, soit comme moyen d'assainissement . . . et de désinfection,* etc., Paris, 1825.

"It was doubtless a very happy circumstance to have arrested animal decomposition, and to have annihilated, as it were, several causes of death. But there remained something still more fortunate: it was that of finding the possibility of arresting decomposition in the living body. I have had the happiness to observe this prodigy performed by the application of the chloruret of oxide of sodium to wounds."

Space will permit the enumeration of only a few of the experiments and reports mentioned by Alcock. In the chapter on "Prevention of Putrefaction in Anatomical Pursuits," he calls attention to the fact that lives have been lost from slight accidents occurring in dissections. He recommends the utmost attention to cleanliness in the anatomical laboratory, a plentiful supply of water, adequate ventilation, the removal of parts no longer of use to the student, and continues:

"The floors should be washed with chloruretted water; the subject under dissection should be sprinkled with a solution of chloruretted lime, renewing the sprinkling as frequently as may be necessary; the cloth covering the subject under dissection to be moistened with a solution of chloruret."

In making pathologic examinations he specifically states that the clothes worn by the operator and assistants have been rendered useless by the intolerable odor which they have retained, and even after every article of dress has been removed and repeated ablutions performed, the hands have retained the disgusting odor for many hours despite efforts to get rid of it. He says:

"Both these inconveniences may be speedily remedied. If the solution of chloruret be freely used during the examination, no such putrid impregnation of clothes can take place; and any offensive odor of the hands may be instantly corrected by washing first in a diluted solution of the chloruret and subsequently in pure water. If the putrefaction of the body be far advanced, it is desirable to moisten the hands with a solution of the chloruret on beginning the examination."

A paragraph describes the disinfection of hospital wards, sick rooms, barracks, guard houses, ships, etc. Then comes the startling announcement that water for domestic purposes may be purified by the addition of 1 or 2 ounces of the chloruret solution to each 60 gallons of infected water. In this suggestion we have the first hint which has led to the chlorination of infected water supplies with the resultant eradication of water-borne diseases.

Alcock states that the reciprocal relations existing between local diseases and constitutional disturbances is well known to those who have faithfully studied the medical profession. Hospital gangrene, the *bête noire* of hospital surgical practice, receives a large amount of attention. Several quotations from French surgeons and French hospital reports culminate in the statement from Lisfranc:

". . . henceforth there will be no gangrene in hospitals, thanks to M. Labarraque."

The finality of this statement of Lisfranc seemed a bit too strong for Alcock and he appends an editorial note with the words "a bold statement." Lisfranc notes that he

". . . has had the good fortune to preserve the limbs of several patients, which were about to be amputated, by applications of the chlorurets."

(b. 1869)[1] states[2] that Dakin's solution "may be looked upon as an improved Labarraque's solution."

The rôle of chlorine in stamping out epidemic puerperal fever received its most startling demonstration in the Rotunda Hospital of Dublin (Fig. 54) at the hands of **Robert Collins** (1801–1896) (Fig. 55). Robert Collins had married the daughter of Dr. Joseph Clarke[3] (1758–1834), formerly master of

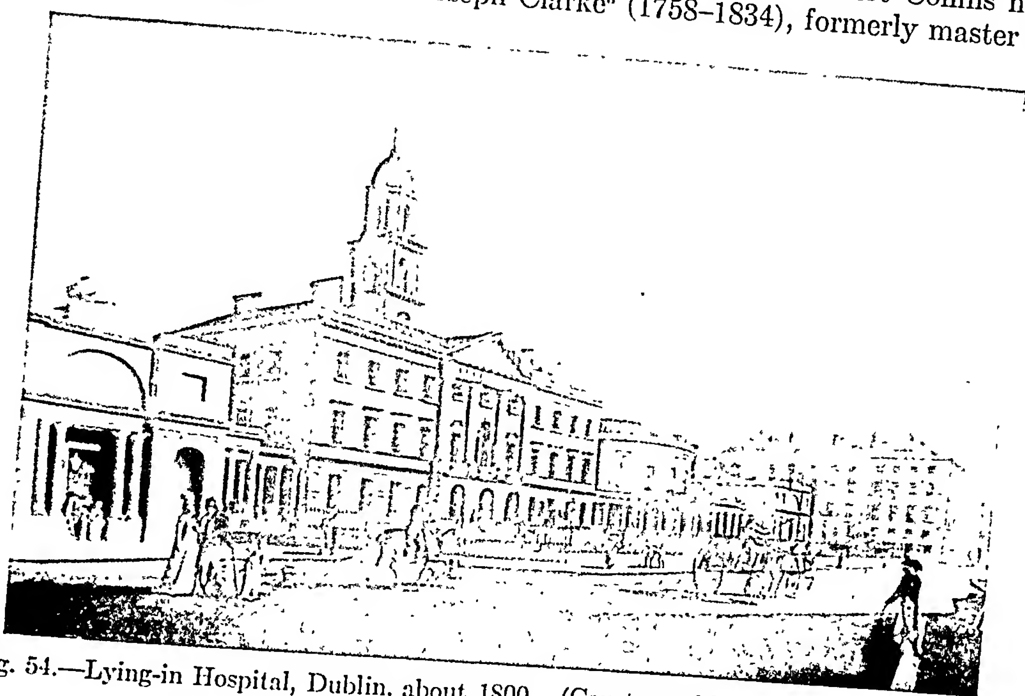

Fig. 54.—Lying-in Hospital, Dublin, about 1800. (Courtesy of T. Percy C. Kirkpatrick.)

the Dublin Lying-in Hospital from 1786 to 1793. Collins had been a student under Samuel Bell Labatt,[4] a former master of the hospital, and an assistant to John Pentland[5] (d. 1826). At the time of his election to the mastership

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entire wound area by means of small tubes connected with a reservoir. Alexis Carrel (b. 1873), surgeon and biologist, received his M. D. in 1900 from Lyons. He began his researches at the Faculté de Médecine where he was prosector. In 1906 he was appointed to the staff of the Rockefeller Institute for Medical Research and became a member in 1912. In the latter year he was awarded the Nobel Prize in physiology and medicine for his contributions to the surgery of blood vessels. Henry Drysdale Dakin (b. 1880) studied at the University of Leeds and at Heidelberg; F. R. S., 1917; editor, *Journal of Biological Chemistry;* member of the Board of Directors of the Russell Sage Institute of Pathology; Chevalier of the Legion of Honour.

[1] Milton Joseph Rosenau, M. D., University of Pennsylvania, 1889; Director, School of Public Health of Harvard University and Massachusetts Institute of Technology from 1913–1922; professor of preventive medicine and hygiene, Harvard Medical School since 1910.

[2] *Preventive Medicine and Hygiene*, New York, 1927.

[3] Joseph Clarke studied at Glasgow University, 1775–1776, and the University of Edinburgh, 1776–1779, receiving his M. D. from the latter in 1779. He studied midwifery in London in 1781 and immediately thereafter began the practice of midwifery in Dublin.

[4] Samuel Bell Labatt received his M. D. from Edinburgh in 1797. Served as assistant master of the Rotunda Hospital under Thomas Evory from August 9, 1800, to August 13, 1803; master of the Rotunda November 4, 1814, to November 2, 1821.

[5] John Pentland received his M. D. from Edinburgh in 1789; became assistant master to Joseph Clarke at the Rotunda Hospital November 8, 1791, which position he held until December 9, 1794. He was elected master of the hospital November 2, 1821, and died in office August 22, 1826.

Recalling this incident and the strenuous efforts at thoroughly cleansing the hospital of every particle of dirt, foul air, etc., Collins realized that cleaning, scouring and painting alone did not suffice. As a result he tried another procedure which he recites with dramatic force:

"In February 1829, at which time I was Master, puerperal fever, which for several months previous had prevailed in the Hospital, now increased much in intensity. On consulting the Medical Committee, it was deemed advisable at once to recommend that no patients, except such as were absolutely destitute, should be admitted; . . . until the entire wards of the Hospital should have been thoroughly purified. We then had all the

A

PRACTICAL TREATISE

ON

MIDWIFERY,

CONTAINING THE RESULT OF

SIXTEEN THOUSAND SIX HUNDRED
AND FIFTY-FOUR BIRTHS,

OCCURRING IN

THE DUBLIN LYING-IN HOSPITAL,

DURING

A PERIOD OF SEVEN YEARS,

COMMENCING NOVEMBER 1826.

BY

ROBERT COLLINS, M.D.

LATE MASTER OF THE INSTITUTION.

LONDON.

LONGMAN, REES, ORME, BROWNE, GREEN AND LONGMAN.

MDCCCXXXV.

Fig. 56.—Facsimile of the title page of *A Practical Treatise on Midwifery* by Robert Collins, London, 1835.

wards in rotation filled with chlorine gas in a very condensed form, for the space of forty-eight hours, during which time the windows, doors, and fire-places were closed, so as to prevent its escape as much as possible. The floors and all the wood-work were then covered with the chloride of lime,[1] mixed with water to the consistence of cream, which was left on for forty-eight hours more. The wood-work was then painted, and the walls and ceilings washed with fresh lime. The blankets, etc. were in most instances scoured, and all stoved in a temperature of between 120 and 130 degrees.

"From the time this was completed, until the termination of my Mastership in November 1833, we did not lose one patient by this disease. As the wards of the Hospital are occupied by the patients in rotation, as soon as each in succession was vacated I continued the use of the chloride of lime, confining its application to the floors. In this way each

[1] The "chloride of lime" was calcium hypochlorite ($CaOCl_2$).

1835 there occurred in the Dublin Lying-in Hospital another serious epidemic of puerperal fever. Robert Collins' treatise was republished in America and must have received generous circulation in Great Britain. He does not appear to have had a single follower in his plan of prophylaxis. Even though we regard Robert Collins' use of chlorine as purely empirical, with only a nebulous idea of the end sought, we cannot withhold from him credit for the most favorable hospital record up to that time. There are many public hospitals today that do not surpass his achievement.

The experiments of Robert Collins came to the attention of Charles D. Meigs of Philadelphia shortly after their publication, and in his *Nature, Signs, and Treatment of Child-bed Fevers;* etc.,[1] Meigs refers to Collins' experiments with chlorine and lime, and remarks:

"Where was the contagion fled? Dr. Collins and his assistants, matrons, and ward-maids were not chlorinized; were they ever, indeed, private pestilences?"

In his *Annals of Midwifery in Ireland,*[2] John Ringland notes that Dr. (later Sir) James Y. Simpson carried on for many years a lengthy correspondence with Dr. Collins over certain questions of obstetrical procedure. Ringland says of Collins:

"Dr. Collins enjoyed most extensive private practice for many years. As a physician he was highly gifted; while, as a consultant, his brethren looked upon him as one of the soundest, safest, most discreet, and high-minded in the profession; and on points of professional ethics or etiquette there were none whose opinion had greater weight. He was for two years—1847–1848—elected President of the King and Queen's College of Physicians, being the first *exclusively* obstetric practitioner who was appointed to that distinguished office."

While Robert Collins was pursuing his remarkable experience in the prevention of puerperal fever in the Dublin Rotunda, **William Henry**[3] (1774–1836) of Manchester was conducting experiments on sterilization by heat. It appears that a cotton importer had requested Dr. Henry to carry on experiments that would insure against the introduction of plague in cargoes of Egyptian cotton landed at Manchester. Because of the then existing quarantine laws, cargoes were compelled to remain in the harbor for prolonged periods. Dr. Henry proceeded to inaugurate a series of experiments designed to ascertain the effect of heat and in an article[4] in the *Philosophical Magazine* in 1831 he says:

"The most important point to be ascertained, and that on which the utility of the inquiry hinges, is whether temperature below 212° Fahrenheit is capable of destroying the contagion of *fomites.*"

[1] Philadelphia, 1854.

[2] Dublin, 1870.

[3] William Henry studied at the University of Edinburgh and afterward assisted his father, Thomas Henry, in general practice at Manchester. He received his M. D. from Edinburgh in 1807. In 1801 he issued *An epitome of chemistry.* This was later much expanded and the title changed to *The elements of experimental chemistry.* To medical science he contributed several papers on calculi, diabetes, etc., as well as observations on cases which fell under his notice as physician to the Manchester Infirmary. An elaborate report on cholera from his pen appeared in the report of the British Association for 1834. In 1808 he was elected F. R. S., and was awarded the Copley gold medal.

[4] *Experiments on the disinfecting powers of increased temperatures, with a view to the suggestion of a substitute for quarantine.* *Philosophical Magazine,* edited by Richard Taylor and Richard Phillips, London, 1831, vol. x, p. 363.

A few months later Dr. Henry published in the same volume of the *Philosophical Magazine*[1] a modification of his original sterilizer (Fig. 57) so situated that infected material could be placed in the chamber of the apparatus in one room and removed in another. In this article he states that he has had no fresh experience with actual experiments but that he desires to submit the design of an improved apparatus, the shells of which he suggests be made of cast iron $\frac{5}{8}$ inch thick, the steam space between to be 2 inches, the outer shell to be covered with a thick casing of some non-conductor. The inside length of the sterilizer is 7 feet and the diameter of the inner shell, 3 feet.

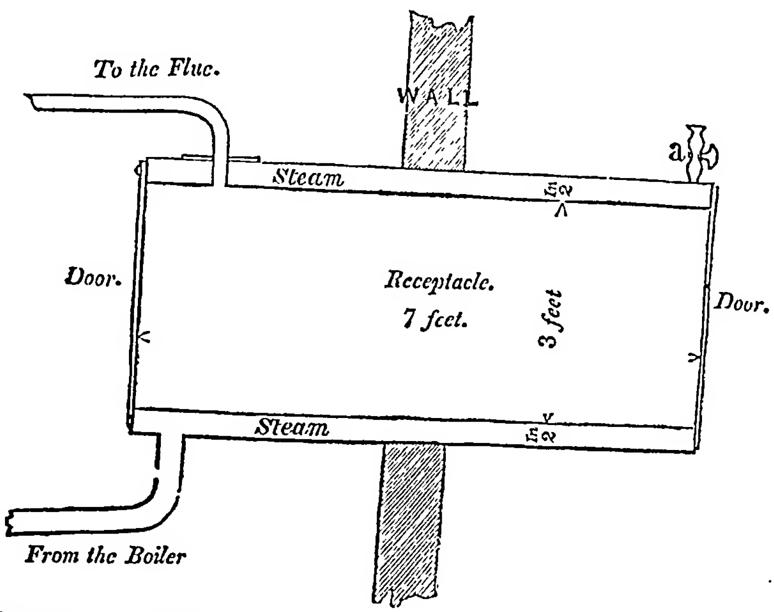


Fig. 57.—Diagram of modified steam disinfecting apparatus devised by William Henry. *Philosoph. Mag.*, 1832, vol. xi, p. 205.

A glance at the diagram of the "improved sterilizer" shows roughly a plan of the modern double-jacket steam sterilizer. No mention is made of increased steam pressure in Henry's articles. It would appear, however, from the construction that, unless the petcock "a" remained open, the pressure in the steam jacket might be raised.

Henry calls attention to the fact that in 1819 there was published[2] a plan devised by a Mr. William Strutt[3] (1756–1830) of Derby for sterilizing infected material by means of dry hot air. No mention is made of the efficacy of this apparatus although a note says that Mr. Strutt's plan was carried into effect at the Derbyshire General Infirmary.

Two interesting works from an extraordinarily prolific author, **Gottfried E. Eisenmann** (1795–1867)—*Die Kindbett-Fieber* (1834) and *Die Wund-*

[1] *Letter from Dr. Henry on a modified disinfecting apparatus.* Volume xi, pp. 205–207, 1832.

[2] *The Philosophy of Domestic Economy.* By Charles Sylvester, London, 1819.

[3] William Strutt devised a system of thoroughly ventilating and warming large buildings, which was carried out with great success at the Derbyshire General Infirmary. He made considerable improvements in the method of constructing stoves, and ultimately invented (1806) the Belper stove. He was an intimate friend of Erasmus Darwin (1731–1802) and was elected a fellow of the Royal Society.

"The disease poison attacks directly some accessible mucous membrane such as that of a wound (or of the mouth, throat, or lung) or of the pregnant uterus; and the poison produces a gelatinous melting or softening, with putrescence. The observation does teach us however that the fever is always the result of putrescence which has actually set in."

Eisenmann says that numerous physicians believe they possess in the chlorine preparations a sovereign remedy against "softening." He says, "In many cases of watery tumor, especially when these follow scarlet fever or smallpox, chlorine was of pronounced help, while in other cases—those following intermittent fever, rubeola, etc.—chlorine failed to save the patient."

He defends his doctrine of wound infection (*Die Wund-Fieber und die Kindbett-Fieber*) rigorously and attributes most diseases to the access of some poison to the circulation through a break in the integument. In his classification of puerperal fever he notes eleven varieties, the second of which is "erysipelous puerperal fever." He notes that fumigation with chlorine will prevent this type of the infection. Not only is the sick person to be bathed with chlorine impregnated water, but the uterus is to be irrigated with the same solution. Throughout the entire volume of 546 pages, chlorine appears to be his chief prophylactic and curative reliance. His work shows an extraordinary familiarity with the literature and approximately 1000 titles are mentioned. He reverts to Harvey's notion of the huge internal ulcer created by the separation of the placenta and cannot get away from the fact that the infection may be admitted to the blood stream through the pulmonary alveoli. His chief contribution to medicine was his work as editor of *Jahresbericht über die Fortschritte der gesammten Medizin*, founded by Carl Friedrich Canstatt (1807–1850) in 1841.

Oliver Wendell Holmes.—We cannot well accuse one of America's foremost men of letters of using a word with a corrupted meaning. We must assume then that Oliver Wendell Holmes (1809–1894) (Fig. 59) used the word "contagious" in its strict etymological sense: that of "touching together" or contact, with its medical application "the communication of disease from body to body by contact direct or mediate." And we must recall that Holmes used the word in exactly the same sense as did White and Kirkland, Denman, and Gordon. This brief explanation seems necessary else we gain the impression that the word was loosely used by Holmes and might include the so-called "noxious conditions of the atmosphere," miasms, telluric influences, etc.

In the minutes[1] of the Boston Society for Medical Improvement[2] which record the proceedings of the meetings for the autumn of 1842, there are found a number of significant case reports and comments relating to puer-

[1] Original minutes read through the courtesy of James Ballard, Librarian of the Boston Medical Library.

[2] The Boston Society for Medical Improvement was originally organized in 1803 by John C. Warren (1778–1856) and James Jackson (1777–1867). It existed for about six years and was revived and incorporated in 1839. At the time of Holmes' essay, the membership was small but select, including Henry I. Bowditch (1808–1892), Walter Channing, John Barnard Swett Jackson, Oliver Wendell Holmes, Gregerson, Gray, George A. Bethune, Woodbridge Strong, C. G. Putnam, Samuel Parkman, Charles E. Ware (1814–1887), Jeffries Wyman (1814–1874), Jacob Bigelow (1787–1879), John Ware (1795–1864), Augustus A. Gould, Joseph Roby (1807–1860), Enoch Hale, Hooper, George Cheyne Shattuck (1784–1854), Edward H. Clarke (1820–1877), John D. Fisher, Solomon Davis Townsend, George Alexander Otis (1830–1881), David Humphreys Storer (1804–1891) and Abel L. Peirson (1794–1853).

noticed a red spot about the size of a pea about half way up his arm, over the radius, and a fine red line extending from it to the thumb. By night these red lines were very numerous. On Tuesday, the arm was very much swelled, and was rapidly increasing, and his fever was very high. He had also sickness at the stomach. . . ."

Dr. Fisher was called and at the time of the report Dr. Whitney was still alive, but in a very precarious condition.[1] One of the students present at the postmortem, who sewed up the body, had no visible wound on his hands. He remained with Dr. Whitney until Wednesday and that night his left arm became painful, also his left side and the glands of his throat. On Friday he had a fever similar in character to that of Dr. Whitney but not so severe, great general soreness, particularly on the left side which had an erysipelas-like appearance. His temperature continued high. On Saturday he was in a dying state and succumbed two hours after Dr. Fisher saw him. The other student had left for his home and remained well.

Some two or three meetings later the minutes record that

"Dr. (Solomon Davis) Townsend[2] (1793–1869) had lost a patient by puerperal fever. A young woman twenty-five years of age was confined of her first child last Thursday at 9 o'clock. The next day there was some frequency of the pulse and hurried respiration which was relieved by oil. On Saturday she took calomel and Dover's powder which was followed by vomiting. She then began to sink and died last Wednesday at 10 o'clock. There was some fullness of the abdomen, but no pain."

Dr. Walter Channing[3] (1786–1876) said that since the last meeting he had seen a case of puerperal fever

". . . which came on thirty-six hours after delivery, and which terminated fatally in two days. He was also called upon yesterday to attend a woman in her 5th confinement. He attended her in her 3d labor when an arm presented. The child was turned and delivered. There afterwards occurred an abscess in the pelvis, which discharged for about a year. The 4th time an arm again presented, and the child was turned and delivered as before. This time an abscess occurred in the right iliac region which kept her confined for a year. Sunday morning he saw her. Her waters had come away in her sleep. An arm was at the os uteri, and there was no pain. The child was turned and delivered stillborn. In the course of an hour it was revived, but afterwards died.

"Dr. Hale said that in addition to the cases of peritonitis which he reported at the last meeting occurring in connection with a case of typhus, there was another case of peritonitis in a niece of the lady, and also one of her domestics (was) sick."

At the meeting on January 9, 1843,[4] officers were elected for the year, and the treasurer's report was presented to an auditing committee consisting of Drs. Oliver Wendell Holmes and Augustus Addison Gould (1805–1866). Dr. Channing reported a case of puerperal fever in his practice following a tedious labor. Within twenty-four hours the patient had chills; Dr. Jackson

[1] Dr. Whitney finally recovered after an illness that lasted many months.

[2] Solomon Davis Townsend performed the second operation under ether anesthesia in America.

[3] Walter Channing was appointed the first professor of obstetrics and medical jurisprudence in Harvard University in 1815, and held the position for nearly forty years. He was one of the first attending physicians at the Boston Lying-in Hospital, and he and John Ware were editors of the *New England Journal of Medicine and Surgery* when that publication became the *Boston Medical and Surgical Journal* in 1828.

[4] The minutes of this meeting record what appears to be an early report by Dr. Putnam of a case of acute appendicitis in an infant. Dr. Channing reported a case of uremia resulting in death.

attack following labor. She recovered. He learned of ten fatal cases of puerperal fever that had occurred recently in Charleston, six in the practice of one physician and four in the practice of another. There had been others in neighboring towns. He said that

". . . . although he had seen many of those fatal cases which had occurred in town, and in many instances had visited them frequently, and had midwifery cases going on at the same time, yet in his own practice he had had no case of puerperal fever. He attended with Dr. Flint all his cases of puerperal fever, and after he left town took charge of his midwifery patients and they all did well."

Dr. Charles Ware reported a case of puerperal fever in his practice:

"A woman was confined on Monday night. The next day she appeared perfectly well except that she had a pulse of 156. She continued the same the next day. On Wednesday night which was extremely cold, the nurse allowed the fire to go out, and she got quite chilled. She was comfortable however the next morning, the milk and lochia being natural, and nothing was said to him of the circumstance. Friday night she had another chill and the next morning complained of a severe pain in her right side as high up as the pleural cavity. Her pulse whenever counted, since her confinement, had been always 156 to 160. At night she appeared to be greatly relieved after a free purgative. On Sunday morning he found her sitting up in bed breathing with extreme difficulty on account of the pain in the side. She had no tenderness or fulness in the abdomen. She soon after however began to sink, her abdomen became full and somewhat tender, her mind wandered, pulse failed, skin became cold and damp, and she died at 6 P. M. Her lochia and milk continued to the last, although during the last few hours they were diminished."

Dr. Homans had seen a case of puerperal fever:

"The woman was confined on Tuesday. On Wednesday she had chills followed by heat and pain. On Saturday he saw her. Her countenance was anxious; her respiration labored; skin hot, abdomen tympanitic, and tender on right side. Her lochia continued. Her secretion of milk was small. Her urine involuntary. The result he did not know.

"Dr. Putnam had had a case which was somewhat anomalous in its symptoms. A woman was confined on Sunday evening, after a rapid labor. On Monday she was well. On Tuesday she was comfortable except that she had a rapid pulse 136. She took oil. In the evening she had headach; her feet became cold, but were afterwards warmed and she had no rigor. She became restless in the night, but had no pain except the headache. On Wednesday morning her tongue was coated, brown; her pulse was feeble, undulating, almost uncountable; countenance stupid; she sank and died that day."

Oliver Wendell Holmes' paper[1] was published in April, 1843, in the *New England Quarterly Journal of Medicine and Surgery* (Fig. 60). There had been republished in Philadelphia in 1842 by Edward Harrington and George D. Haswell the several essays on puerperal fever of Gordon, William Hey,[2] John Armstrong, and Robert Lee.[3] Holmes no doubt had access to this volume as well as to other widely scattered essays on puerperal fever by various writers. With the power of a forceful rhetorician and with sound logic Holmes summed up the evidence and stated his case so clearly that any physician, in whose practice puerperal fever occurred, would, *de facto*, have constituted himself a "private pestilence." His rules of conduct were similar to those previously laid down by Lee and by James Copland[4] (1791–1870)

[1] *The contagiousness of puerperal fever.*

[2] *A Treatise on the Puerperal Fever: Illustrated by Cases which occurred in Leeds and its Vicinity, in the years 1809–1812.*

[3] *On Puerperal Fever and Crural Phlebitis.*

[4] James Copland graduated from Edinburgh in 1815, and was made a licentiate of the College of Physicians, 1820. Wrote articles for *Foreign Quarterly Review*, and *Medical Repository*. Published *Dictionary of Practical Medicine* in 1832.

read at a meeting of the Boston Society for Medical Improvement, at whose request it was given to the press. The periodical in which it appeared, though well-conducted and promising well, died in its first year, having been seen by few readers and supported by few subscribers. My warning and counsel had their effect, however, in our own community, as I have often been assured by competent authorities. The essay attracted respectful notice abroad, as the names of Copland and Ramsbotham and the Fifth Annual Report of the Registrar-General of England sufficiently show. Still, it was not read by some who might have profited by it. If Dr. (afterwards Sir James) Simpson had read the first rule I laid down, he would not have left the record that after freely handling the diseased parts from an autopsy of a victim of puerperal fever his next four child-bed patients were affected with that disease.

"I thought I had proved my point, and set the question of the *private pestilence*, as I called it, at rest 'for good and all.' I thought I had laid down rules which promised to ensure the safety of the lying-in woman from disease and death carried to her unconsciously by her professional attendant.

"Still I was attacked in my stronghold by the two leading professors of obstetrics in this country.[1]

"I defended my position with new facts and arguments and not without rhetorical fervor, at which, after cooling down for half a century, I might smile if I did not remember how intensely and with what good reason my feelings were kindled into the heated atmosphere of superlatives.

"I have been long out of the way of discussing this class of subjects. I do not know what others have done since my efforts; I do know that others had cried out with all their might against the terrible evil before I did, and I gave them full credit for it.

"But I think I shrieked my warning louder and longer than any of them, and I am pleased to remember that I took my ground on the existing evidence before the little army of microbes was marched up to support my position."

In the *Professor at the Breakfast Table*,[2] Holmes has the Professor say:

"When, by the permission of Providence, I held up to the professional public the damnable facts connected with the conveyance of poison from one young mother's chamber to another's,—for doing which humble office I desire to be thankful that I have lived, though nothing else good should ever come of my life,—I had to bear the sneers of those whose position I had assailed, and, as I believe, have at last demolished, so that nothing but the ghosts of dead women stir among the ruins."

Holmes' teaching was nullified in large measure by the virulent opposition of the Philadelphia professors of midwifery, Charles D. Meigs (1792–1869) of Jefferson Medical School and Hugh L. Hodge (1796–1873) of the University of Pennsylvania. The following is a paragraph from Meigs' book[3] which explains his view of the pathology of the pregnant woman:

"A woman pregnant, is often observed to labor as to her circulation; she becomes sometimes plethoric and hyperinotic; at other times she is to the last degree hydraemical. The force of her haematosis is exaggerated or exhausted, as the case may be, and the direct fault, the pathological fault, is to be traced to a state of Endangium, which is her blood-making tissue, her blood-membrane, and which has the same relation to the function of haematosis, as the gastro-enteric mucous membrane has to the process of her digestions. If the digestive organs become diseased, the power of digestion falls proportionally; if the haematosic tissue becomes diseased, the haematosis fails in like manner."

Dr. Hodge in a (introductory) lecture *On the Non-contagiousness of Puerperal Fever* delivered at Philadelphia on the 11th of October, 1852, concluded as follows:

[1] Charles D. Meigs and Hugh L. Hodge.
[2] First edition, Boston, 1860.
[3] *On the Nature, Signs and Treatment of Childbed Fevers: in a series of Letters addressed to the Students of his Class.* Philadelphia, 1854.

In an earlier article, *On the Contagiousness of Puerperal Fever*,[1] Kneeland quotes Justus von Liebig (1803–1873) to the effect that the action of certain poisons on the body is similar to the process of fermentation. Among Kneeland's conclusions is one paragraph that embodies well-nigh the complete etiology of Semmelweis:

". . . it may be propagated by direct inoculation with the fluids of living and the dead; by the effluvia arising from the bodies of the sick, inhaled in the very chamber of death (as in the wards of a hospital), or carried about by the person of the physician; by clothes, bedding, (fomites), which have been in contact with a diseased individual."

Again he says:

"The epidemic of puerperal fever is the effect and not the cause of the contagion."

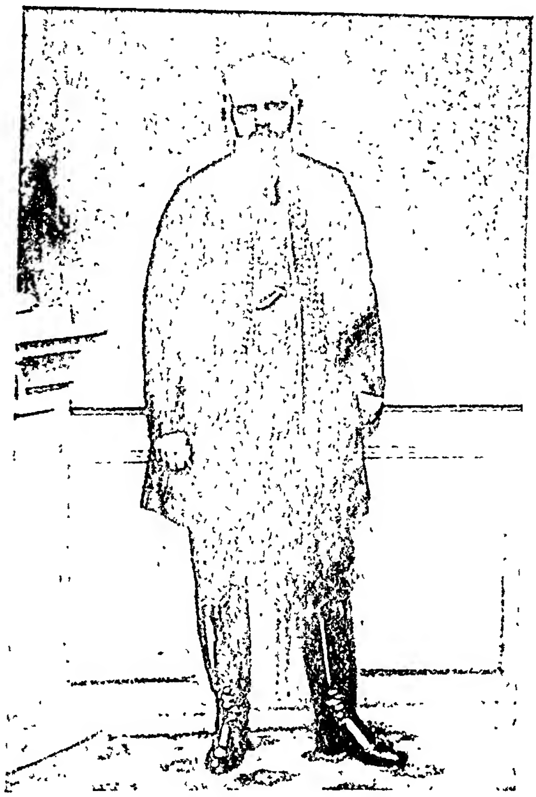


Fig. 61.—Ignaz Philipp Semmelweis in 1863. (From the author's collection.)

Ignaz Semmelweis[2] (1818–1865) (Fig. 61) obtained the first hint of his Lehre from the significant facts disclosed at the autopsy of his colleague, Kolletschka, who died from the effects of a wound incident to a postmortem examination. Semmelweis says:

". . . . In the excited condition in which I then was, it rushed into my mind with irresistible clearness that the disease from which Kolletschka had died was identical with that from which I had seen so many hundreds of lying-in women die. The puerperæ also died from phlebitis, lymphangitis, peritonitis, pleuritis, meningitis, and in them also metastases sometimes occurred.

[1] *American Journal of the Medical Sciences*, n. s., vol. xi, 1846.

[2] *Die Aetiologie* contains a considerable amount of autobiographic material and Semmelweis' own account has been drawn upon in this narrative.

Sometime in November, 1847, a second outbreak of puerperal fever occurred which was laid at the door of a woman in the lying-in ward who was suffering from caries of the knee joint. Of this case Semmelweis says:

"The foul exhalations from the carious joint were so strong that the air of the labor room in which she was confined, was so loaded that all the patients in the same room became infected, and nearly all died. . . . The air of the labor room, loaded with the putrid matter, found its way into the gaping genitals just at the completion of labor and onward into the cavity of the uterus where putrid matter was absorbed and puerperal fever was the consequence."

Early in December, 1847, subsequent to this epidemic, in which nineteen deaths occurred in the ward in which the woman with the carious knee joint was confined, Semmelweis added a further addendum to his Lehre, which may be stated as follows:

Lehre III. Puerperal fever may be conveyed to the pregnant woman subsequent to delivery by foul air loaded with exhalations from putrefying animal matter, the putrid material finding its way through the air to the genitalia.

Semmelweis was no doubt familiar with the recent claims for chlorine disinfection. He had probably tried or seen demonstrated the power of chlorine to remove odors. Nothing can be found in Semmelweis' writings that would lead one to believe that he thought material that did not emanate a foul odor could be infectious. To him destruction of the odor meant destruction of the poison. Hands washed in a solution of chlorinated lime did not smell, therefore, they could not convey cadaveric poison. In the case of the woman with the foul cancer of the cervix and the woman with the carious knee joint, the odor was proof positive of infection.

By the end of 1847 Semmelweis stood squarely on the three sources of infection above noted and maternal mortality from puerperal fever with the exception of the two epidemics, had dropped to slightly below 3 per cent. Publication was now important and the task fell upon Ferdinand von Hebra (1816–1880), who was editor of the journal of the medical society of Vienna. Hebra's article entitled *Experience of the highest importance concerning the etiology of epidemic puerperal fever at the Lying-in Hospital*, appeared in December, 1847.[1] In this article Hebra says:

"By daily visits to an institution of pathology and anatomy Dr. Semmelweis had learnt what were the injurious influences which were produced by filthy and putrid fluids upon even unwounded portions of the body of individuals engaged in postmortem examinations. These observations aroused in him the thought, that perhaps in lying-in hospitals the pregnant and parturient patients might be inoculated by the accoucheur himself, and that puerperal fever was in most cases nothing else than cadaveric infection."

Hebra points out that in April and May, 1847, before chlorine disinfection of the examining hand had been instituted, out of 100 cases of labor there were 18 deaths. As soon as chlorine disinfection was ordered, from May to December, 1847, the mortality had dropped to 2.45 per cent. In conclusion Hebra invited the directors of all lying-in hospitals to submit their observations and experience.

Considerable delay in grasping the rôle of the examining finger was occa-

[1] *Zeitschrift der k. k. Gesellschaft der Aertze zu Wien*, 1847–1848, vol. iv, part 2, p. 242.

He further calls attention to the presence of surgical disease in general hospitals, the putrid products of which may give rise to childbed fever and indicates that a patient may even infect herself in rare cases

". . . owing to the retention of organic matter which should have been expelled in child bed. Before its expulsion decomposition has already begun, and when absorption occurs puerperal fever is induced by Self-infection. These organic materials are the lochia, remnants of decidua, blood coagula which are retained within the cavity of the uterus."

He further notes that the

". . . forcible use of midwifery forceps, causing gangrene or bruised portions of the genital organs may cause child-bed fever by self-infection. When we declare that child-

Die Aetiologie, der Begriff

und

die Prophylaxis

des

Kindbettfiebers.

Von

Ignaz Philipp Semmelweis,

Dr. der Medicin und Chirurgie, Magister der Geburtshilfe, o. ö. Professor der theoretischen und practischen Geburtshilfe an der kön. ung. Universität zu Pest etc etc.

Pest, Wien und Leipzig.

C. A. Hartleben's Verlags-Expedition.

1861.

Fig. 62.—Facsimile of the title page of *Die Aetiologie, der Begriff und die Prophylaxis des Kindbettfiebers* by Ignaz Philipp Semmelweis, Pest, 1861.

bed fever is a resorption fever in which as the result of absorption a blood-poisoning occurs, and then exudation follows, we do not imply that puerperal fever is peculiar to the lying-in woman and restricted in its incidence to lying-in women. We have met with the disease in pregnant women and in new-born infants without regard to sex. This is the disease which was fatal in the case of Kolletschka; and we find it affecting anatomists, surgeons, and patients who have undergone surgical operations. Puerperal fever is therefore not a species of disease; puerperal fever is a variety of Pyæmia."

He denies that puerperal fever is contagious, that is, that it can produce a contagion which in turn can produce in another individual the same disease. Further Semmelweis says:

discovery, but that alone was no more important than Charles White's sanitation of the sick room or the positive lessons from the experience of Robert Collins or the clear and logical rules of conduct laid down by Holmes.

In the case of the woman with the carious knee, Semmelweis did not dress the infected area with chlorine solution as had been recommended by Labarraque, Alcock, and Lisfranc more than twenty years earlier. Neither did he immediately isolate this offending individual as had been considered necessary by Charles White nearly seventy-five years earlier. Neither did he cover the floor of the ward with chlorinated lime as did Collins, nor does he mention in this or any similar circumstance the necessity of thoroughly cleaning the room. From Lehre I in 1847 to Lehre V in 1861, Semmelweis had expanded his doctrine by accepting practically all of the proved positions taken by the early English obstetricians. He held that puerperal fever was not a disease *sui generis*—so had Kirkland and many others; he said that puerperal fever was a resorption fever—so had White and his followers. All that Semmelweis had noted about the etiology and the mode of spread except Lehre I had been noted and proved by others. His Lehre I remains a new and distinct discovery in proof of which he supplied positive clinical evidence.

Fate played cruelly with Semmelweis. In July, 1865, after many consultations relative to his condition, Semmelweis was admitted to the Vienna hospital for the insane. Shortly after his admittance it was found that he was suffering from an infection on one of the fingers of his right hand. When discovered, the wound was sloughing and cellulitis had spread upward along the forearm. The infection slowly progressed and his death occurred on August 13th. He died a victim of the infection which he had so vigorously fought to prevent in puerperal women.

Four years after the publication of *Die Aetiologie*, Joseph Lister of Glasgow performed a surgical operation under antiseptic precautions, the lesson of which was to dissipate the clouds of doubt and explain with crystal clearness the processes of infection. Antisepsis was followed by asepsis and each was applied in turn to midwifery and gynecology. By many J. J. Bischoff (1841–1892) of Basle, Switzerland, is credited with having made one of the early applications of Lister's principle to midwifery. Carbolic washings of the hands, carbolic acid impregnated dressings, pads, etc., were employed and soon many midwifery clinics throughout the world were reporting long series of deliveries without a single case of puerperal fever.

MIDWIFERY IN AMERICA. THE DEVELOPMENT OF GYNECOLOGY

Colonial America followed the example of England in the transition from the practice of midwives to that of men physicians who had acquired some special training and experience in obstetrics. For more than a century after the planting of colonies in America, midwives held the field and in the early records they are frequently named and their services duly acknowledged. In the Dutch colony of New York rules and regulations for the government of midwives were enacted. The midwife was bound by a solemn oath to perform her duties thoroughly and painstakingly and not to charge fees beyond a certain scheduled rate. It is recorded that occasionally midwives were rewarded by the Colonial Council for work among the poor. The records of many old New England towns record the names of midwives who acquitted themselves with credit, notably, Mrs. Fuller, Anne Hutchinson (1600–1643),

The first specialist in midwifery in Philadelphia was a **Dr. Spencer,** who is mentioned by Thomas Cadwalader[1] (1708–1779). George W. Norris says:[2]

> "We learn from Dr. Cadwalader, that so early as 1745, a Dr. Spencer was largely engaged in our city, who had returned from Europe 'recommended by the famous Dr. Mead, and several other eminent gentlemen of the Faculty of London, as a most judicious and experienced physician and man-midwife'; and three years subsequently, Dr. Thompson also was practising in that branch."

Spencer is also referred to in Cadwalader's *An Essay on the West-India Dry-Gripes;* etc.,[3] as explaining the effect of the several states of the atmosphere on the human body in a series of "philosophical lectures exhibited by Dr. Spencer in Philadelphia last summer."

According to Packard, **John Dupuy,** M. D., was a practitioner of midwifery in New York City. His death occurred in 1745.

William Douglass (1692–1752), a physician of Boston, in *A Summary, Historical and Political, of the . . . British Settlements in North America*[4] mentions a **Dr. Peter Billing** who is referred to in the *New York Gazette* for December 16, 1751, as "an experienced physician and man-midwife."[5]

With the development of midwifery teaching in London somewhat earlier than the middle of the eighteenth century, American physicians studying in England availed themselves of the midwifery courses offered by prominent London teachers—Sir Richard Manningham, William Smellie, William Hunter, John Leake, William Osborn and Thomas Denman.[6] Better prepared for the practice of midwifery than their colleagues, these Americans for the most part returned to the colonies and announced themselves as especially qualified to care for "preternatural and difficult births." A few, actuated with the desire to teach, established a plan of instruction modeled after the private midwifery schools of London. Midwifery teaching in America was thus inaugurated by returned European-trained American students assisted by English and Scottish physicians who had emigrated to the colonies. There is ample evidence to show that lectures and demonstrations to men physicians and possibly to female midwives were given by James Lloyd in Boston, William Hunter in Newport, and William Shippen, Jr., in Philadelphia.

[1] Thomas Cadwalader is believed to have been the first in America to teach practical anatomy (1730) and to have performed the first scientific autopsy (1742). He was one of the founders of the Philadelphia Library and of the Pennsylvania Hospital.

[2] *The Early History of Medicine in Philadelphia.* Philadelphia, 1886.

[3] Philadelphia, 1745. This was printed by Benjamin Franklin and is one of the rare Franklin imprints.

[4] Two volumes, London, 1755.

[5] Douglass regarded Peter Billing as a notoriously advertised quack. The article in question details the cure by Peter Billing of a woman who had been insane for eighteen years and concludes:

"N. B. The contagious distemper so frequently happening to the bold adventurers in the wars of Venus, when recent, will be cured by him (Dr. Peter Billing) for three pistoles in hand, though the common price is five pound all over North-America. And all other cases curable in physic and surgery proportionate to the circumstances of the people." Douglass further notes that Dr. Peter Billing sells a medicine to prevent yellow fever and dry gripes in the West Indies. Commenting on the extravagance of this claim, Douglass notes that it is comparable to the pills sold in Jamaica to prevent "persons and their effects suffering from earthquakes."

[6] See chapter on *Development of Clinical Midwifery in Great Britain.*

1896). Lloyd was the first American surgeon to use ligatures instead of the cautery in arresting hemorrhage.

William Hunter (1729–1777) was born in Scotland and pursued his medical studies in Edinburgh, where he came in contact with the elder Monro,[1] and in the University of Leyden. He settled in Newport, Rhode Island, about 1752 and lectured to medical students on anatomy and midwifery. His reputation as a successful surgeon and obstetrician was established throughout the colony. His medical library, said to have been the largest in New England, was dispersed by his descendants subsequent to the close of the Revolution.

Fig. 64.—William Shippen, Jr. Portrait accompanying article by Colonel P. M. Ashburn in *Surg., Gyn. and Obst.*, 1930, vol. l, p. 120.

William Shippen, Jr. (1736–1808) (Fig. 64), was a graduate of the College of New Jersey (Princeton). Subsequent to three years of study with his father, Dr. William Shippen[2] (1712–1801), he went to Europe in 1757 where he studied anatomy with John Hunter and midwifery under William Hunter and Colin Mackenzie. He took his degree at Edinburgh. In 1762 he returned to America reaching Philadelphia in May,[3] and in the autumn of that year

[1] Alexander Monro *primus* (1697–1767) became professor of anatomy in the newly established University of Edinburgh in 1720 and was the first of the Monro succession that controlled the teaching of anatomy and surgery in that institution for one hundred and twenty-six years.

[2] William Shippen was one of the founders of the University of Pennsylvania as well as of the College of New Jersey (Princeton); was the first physician of the Pennsylvania Hospital, 1753–1778.

[3] *Eulogium on William Shippen, M. D. &c.* delivered before the College of Physicians of Philadelphia, March, 1809. By Caspar Wistar. *The Philadelphia Journal of the Medical and Physical Sciences*, vol. v. Philadelphia, 1822.

Morton and Woodbury[1] quote the following excerpt from the *Pennsylvania Gazette* of January 1, 1765:

> "Dr. Shippen, Jr., having been lately called to the assistance of a number of women in the country, in difficult labors, most of which was made so by the unskillful old women about them, the poor women having suffered extremely, and their innocent little ones being entirely destroyed, whose lives might have been easily saved by proper management, and being informed of several desperate cases in the different neighborhoods which had proved fatal to the mothers as to their infants, and were attended with the most painful circumstances too dismal to be related, he thought it his duty immediately to begin his intended courses in Midwifery, and has prepared a proper apparatus for that purpose, in order to instruct those women who have virtue enough to own their ignorance and apply for instructions, as well as those young gentlemen now engaged in the study of that useful and necessary branch of surgery, who are taking pains to qualify themselves to practice in different parts of the country with safety and advantage to their fellow citizens."

From the above it would appear that although Shippen had announced a course in midwifery at an earlier date, lectures were probably not given, due to the fact that the registration did not warrant. The remark

> ". . . . he thought it his duty immediately to begin his intended courses in Midwifery . . ."

would seem conclusive.

From time to time Shippen probably republished the announcement of his proposed lectures on midwifery. From these announcements as well as from Norris' quotations, we are able to obtain many hints as to the nature of the course. Shippen stated that he expected to furnish each pupil with at least one natural labor and the following paragraph would indicate the first use of the obstetrical manikin in America:

> "I have provided a machine, by which I can demonstrate all kinds of laborious and preternatural labors, and shall give every necessary direction to enable you to manage all cases with the greatest safety to mother and child."

The topics of his lectures as announced were:

"1. On the Bones of the Pelvis.
2. Male and Female Organs.
3. Changes in the Uterus.
4. On the Placenta.
5–6. On the Circulation and Nutrition of the Foetus.
7. On the Signs of Pregnancy.
8. On the Menses.
9. Fluor Albus.
10. On Natural Labours.
11. et seq. On Laborious and Preternatural Labours, with the Use of Instruments; and concluded by particular lectures on the Diseases of Women and Children within the month, and directions concerning the diet of each, and methods of choosing and making good nurses."

As may be understood, Shippen's efforts to create enthusiasm for midwifery were fraught with much discouragement. While medicine and surgery were dominant and under the immediate jurisdiction of trained men, midwifery was relegated for the most part to ignorant women who fostered the idea that it was improper and indelicate for a woman in labor to be attended

[1] *The History of the Pennsylvania Hospital, 1751–1895.* Thomas G. Morton and Frank Woodbury, Philadelphia, 1895.

plan of the extramural courses given in Edinburgh and the independent teaching of midwifery in London and Glasgow. Norris notes that in 1793 Dr. Benjamin Duffield gave a course on midwifery in each of several summers. On his death in 1799, Duffield's lectures were continued by Thomas C. James assisted by Dr. Church in the lying-in ward of the Philadelphia Almshouse. Dr. Church's untimely death from yellow fever provided a place for Nathaniel Chapman[1] (1780-1853), who continued the lectures with Dr. James until the latter's appointment to the professorship of midwifery in the University of Pennsylvania in 1810. Toward the close of the century a Dr. Price of London lectured on the practice of physic and on midwifery and diseases of women and children. About the same time (1797), William P. Dewees announced "a regular and extensive course on obstetrics."

Obstetrical conditions requiring surgery were in many instances crudely managed and from the meager published reports one may gather that the waiting policy pursued by the midwives cost many lives. References may be found to the operation of dismembering the fetus and to craniotomy. The existence of extra-uterine pregnancy was occasionally recognized but was looked upon as a surgical condition wholly removed from the domain of midwifery. A few early reports of this condition will serve to evidence the resourcefulness of the attending surgeons. The first report of extra-uterine pregnancy emanating from America was that of **John Bard** (1716–1799) which was sent to John Fothergill[2] (1712-1780) of London and read by him before the Society of Physicians of London on March 24, 1760.[3] John Bard's report details a case in which a woman, twenty-eight years of age, had been delivered of a normal child. She became, as she thought, pregnant a second time. At the end of the period of gestation, while some pains were complained of, no delivery occurred. The abdominal tumor gradually decreased in size, leaving "a large, hard, indolent tumor inclining a little to the right side." The menses returned and the patient continued to enjoy excellent health for several months. She again became pregnant and at the end of the normal period was delivered of a healthy child, the tumor on the right side remaining unchanged. Subsequent to this delivery she developed a temperature and Dr. Bard on examination detected definite fluctuation in the tumor. After consultation the conclusion was reached that the tumor contained an extra-uterine fetus which had undergone degeneration and it was determined to incise the tumor in its most prominent part. This operation was performed, a large quantity of fetid pus was evacuated and a fetus that apparently had died at full term was extracted, and

". . . by the use of fomentations the cavity . . . contracted, filled up, and was cicatrised in ten weeks. . . ."

The patient quickly recovered her good health.

[1] Nathaniel Chapman received his M. D. in 1801 from the University of Pennsylvania. In 1817 he founded the Medical Institute of Philadelphia—the first postgraduate medical school in the United States. In 1820 he was editor of the *Philadelphia Journal of the Medical and Physical Sciences.*

[2] John Fothergill, one of the most distinguished physicians of the day, was a warm friend of the American colonies and played an important rôle in the founding of the Pennsylvania Hospital.

[3] *Medical Observations and Inquiries*, vol. ii, 1762.

incident she remained in poor health. She gradually improved, however, and in recent years had been perfectly well. Baynham promptly pronounced the case one of extra-uterine conception and advised against interference at the time. Three years later the patient suffered an attack of influenza, subsequent to which Baynham was summoned and found that the tumor had shifted toward the midline and that the external abdominal wall showed a disposition to gangrene. Baynham incised the abdominal wall without removing the fetus. This wound healed but the patient declined in health, and on January 14, 1791, he determined to remove the fetus. This he accomplished with no untoward result and the patient subsequently enjoyed excellent health.

His second case was that of a patient whom he was called to see on January 24, 1799. This patient gave a history of pregnancy that had continued for eighteen months. Examination disclosed a situation similar to that of his first case and he operated on February 6th, finding an extra-uterine fetus which was removed. This patient made a normal recovery.

In the same volume of the *New York Medical and Philosophical Journal and Review*, **J. Augustine Smith**[1] of New York reports a case of extra-uterine conception which he removed by an operation. The patient had become pregnant about twelve months before. Examination disclosed a normal uterus and an abdominal tumor about the size of a full-term pregnancy. The integuments of the abdomen had broken down near the umbilicus, two sinuses had developed, and the patient was septic. Because of the immediate danger Dr. Smith opened the tumor and extracted a "four to seven months fetus." The patient made a favorable recovery.

J. Whitridge Williams says[2] that similar operations were performed by Charles McKnight[3] (d. 1792) of New York and by David Ramsay[4] (1749–1815) of Charleston in 1803. In 1802 George Osgood reported a laparotomy for extra-uterine pregnancy,[5] and in 1816 John King of Edisto-Island, South Carolina, reported a similar case[6] which was remarkable for the procedure adopted and the fact that the child was delivered alive. John S. Parry

[1] John Augustine Smith was professor of anatomy and surgery in the College of Physicians and Surgeons, 1808–1811; during the reorganization of the faculty in 1811 he was elected professor of anatomy, surgery and physiology which position he shared with Wright Post (1766–1828) when the union of Columbia College and the College of Physicians and Surgeons was effected in 1813. He was president of the college from 1831 to 1843.

[2] *Die Geburtshülfe in Amerika* included in *Geschichte der Geburtshülfe der Neuzeit.* By Rudolf Dohrn. Tübingen, 1903.

[3] Charles McKnight was professor of anatomy and surgery in Columbia College, 1785–1792. McKnight communicated his case to James Mease (1771–1846) of Philadelphia, who sent the report to John Coakley Lettsom (1744–1815). The report was published in the *Memoirs of the Medical Society of London*, 1795, vol. iv.

[4] David Ramsay graduated from Princeton in 1765 and began his medical studies at the University of Pennsylvania under Thomas Bond (1712–1784), receiving the degree of Bachelor of Physic in 1772. In 1773 he moved to Charleston, South Carolina, where he became prominent in medical practice and public affairs. He became best known as an author and historian.

[5] *Remarkable Extra-Uterine Case. Medical Communications*, Mass. Med. Soc., Boston, 1802, vol. i.

[6] *Case of an Extra-Uterine Fetus, produced alive through an Incision made into the Vagina of the Mother, who recovered after Delivery, without any alarming Symptoms. Medical Repository*, 1817, vol. iii.

Patterson Harris (1822–1899) published a statistical study[1] of 72 cases of cesarean section that had been performed in the United States with a mortality of 51 per cent.[2]

The earliest published operation in America is that of **John Lambert Richmond** (1785–1855) of Newton, Ohio, who reports[3] a case upon which he operated in 1827. On April 22nd, he was called to a colored woman who had been in labor some thirty hours and who exhibited symptoms of eclampsia with frequent convulsions. As a last resort Richmond resolved to attempt cesarean section, operating at one o'clock in the morning, with only a few instruments from a pocket case. The incision in the uterus was directly in line with the placenta which was detached before delivery of the fetus. The operation was completed, the abdominal wall sutured, and drainage left in the lower angle of the wound. Twenty-four days subsequent to the operation the patient was up and about.

With the discovery of anesthesia and the development of asepsis, cesarean section was resorted to with more or less frequency by the skilled obstetrician.

The gradual march of progress in midwifery in America may be readily understood by a cursory survey of the several centers of midwifery teaching associated with the medical schools. Midwifery, as we have noted, was at first compelled to assume a subordinate place in organized medical teaching in comparison with surgery and the practice of physic. There were comparatively few well-trained obstetricians and but few of these devoted their entire time and attention to obstetrics. The European example of male midwives and male accoucheurs could not be followed because of the meager population of even the principal cities and the further fact that the people were not specialty-minded. Even those who gave instruction in midwifery practiced general medicine and surgery. With the increase of population and the ability of America to offer reasonably adequate medical training, teachers of midwifery became more numerous and beginning with the period of Dewees at the University of Pennsylvania, midwifery was recognized as a special field of great importance. The transition from the private instruction of William Shippen, Jr., to the well-organized departments of Meigs and Hodge is of the greatest significance.

In 1791, when the College of Philadelphia was merged with the University of the State of Pennsylvania to form the University of Pennsylvania, William Shippen, Jr., was appointed professor of anatomy, surgery and midwifery. In 1805 he was relieved of the teaching of surgery through the election to that chair of Philip Syng Physick. Shippen continued to teach midwifery and anatomy until his death in 1808. His immediate successor was Caspar Wistar[4] (1761–1818), who was not interested in midwifery and promptly

[1] *The Operation of Gastro-Hysterotomy (true Cesarean Section), Viewed in the Light of American Experience and Success;* etc. *The American Journal of the Medical Sciences,* April, 1878, n.s., vol. lxxv.

[2] See also earlier report by Harris in the *American Journal of Obstetrics,* vol. iv.

[3] *History of a successful case of Cesarean Operation. Western Medical and Physical Journal,* 1830, vol. iii.

[4] Caspar Wistar was a private pupil of John Redman (1722–1808), attended the practice of John Jones and the lectures of John Morgan, William Shippen, Jr., Benjamin Rush (1745–1813) and Adam Kuhn; he received his B. M. in 1782 and his M. D. from Edinburgh in 1786. He served as physician to the Philadelphia Dispensary established in 1787; was professor of chemistry and physic in the College of Philadelphia in 1789; physician to

to this latter work a high place and Hugh L. Hodge stated that he considered it superior to the work of Denman, Burns, Osborn and other English writers. Dewees' midwifery attracted notable attention in numerous European centers of medical education and the author was acclaimed a worthy contemporary of the best European writers on the subject. Numerous complimentary notes on his work appeared from time to time in British medical journals and John Ramsbotham of London dedicated to Dewees the second part of his *Practical Observations on Midwifery*.

Fig. 65.—William P. Dewees. Portrait from *American Medical Biography* by Stephen W. Williams, Greenfield, 1845.

Dewees may be said to have laid the foundation of scientific midwifery in America and it is certain that the influence which he wielded through his teaching and writings widely disseminated a knowledge of the best in midwifery. Hugh L. Hodge says of James and Dewees:

> "Drs. James and Dewees should be regarded as the fathers of obstetric science in America; the former, erudite and polished, gave currency to teachings of the British schools; the latter, more vigorous and energetic, exemplifying theoretically and practically the doctrines of the French obstetricians."

Hugh Lenox Hodge[1] (1796–1873) (Fig. 66) followed Dewees as professor of obstetrics in the University of Pennsylvania. His first work on gynecology

[1] Hugh Lenox Hodge received his M. D. from the University of Pennsylvania in 1818. He served as physician to the Southern Dispensary and the Philadelphia Dispensary for a time, and during William E. Horner's (1793–1853) absence in Europe (1840) Hodge lectured to his class in anatomy. Because of failing eyesight, Hodge resigned his professorship of obstetrics in 1863.

was issued in 1860 under the title *On Diseases Peculiar to Women, including Displacements of the Uterus*, and his *The Principles and Practice of Midwifery* followed in 1864. Hodge's articles attracted the attention of foreign students and unusually favorable reviews of his writings appeared in many British periodicals.

Hodge is to be remembered particularly for his advocacy of the induction of labor before full term whenever the pelvis is found to be contracted, or where earlier pregnancies have resulted in stillbirths. He modified the Smellie forceps and devised many useful obstetrical instruments. He is probably best known for the pessaries which he designed and which were widely used prior to the development of operative procedures for the correction of prolapse and malpositions of the uterus. His lever pessary had a wide vogue and is still much used. Hodge employed photography to demonstrate the relation between the fetal head and the pelvis, and was the first to make a plaster model of the parturient canal.

Hodge's work at the University of Pennsylvania was ably supported by that of **Charles D. Meigs** (1792–1869) (Fig. 67), professor of obstetrics at Jefferson Medical College. Meigs was not only a prolific writer, but a teacher of great power. His first published volume, *The Philadelphia Practice of Midwifery*, appeared in 1838, seven years before his appointment to the professorship at Jefferson. Meigs dedicated his book to René La Roche[1] (1795–1872), a co-editor of the *North American Medical and Surgical Journal*. He says:

> "For several years I have been engaged in delivering lectures on Midwifery and the Diseases of Women and Children, in this city, and I have been repeatedly asked to publish a volume on Obstetric subjects, adapted to the use of students."

The volume was the result of a definite demand on the part of the members of his class in the Philadelphia School of Medicine. In the section devoted to forceps (Chapter XVI), Meigs gives the reader a number of very interesting sidelights on the Philadelphia practice of the period. There is occasional mention of Philip Syng Physick, William P. Dewees, Thomas Chalkley James, Thomas Tickell Hewson[2] (1773–1848) and J. Ray Martin. The second edition was issued in 1842. Five years later (1847) *Woman, Her Diseases and Remedies* was published, followed in 1849 by *The Science and Art of Obstetrics*. This latter work, of which several editions were published, was a greatly enlarged and improved rewriting of his text on obstetrics. A year later he issued a work on the acute and chronic diseases of the cervix, and trans-

[1] René La Roche graduated from the University of Pennsylvania in 1820. He was closely associated with Meigs and Hodge in the Kappa Lambda association and the Monday Evening Medical Club of Philadelphia. His history of yellow fever is one of the important medical monographs.

[2] Thomas Tickell Hewson was a son of William Hewson (1739–1774) of London, a pupil and assistant of the Hunters. His mother was Polly Stevenson—"Dear Polly" so frequently mentioned in the correspondence of Benjamin Franklin. (See *My Dear Girl* by J. M. Stifler, New York, 1927.) Thomas Hewson graduated from the University of Pennsylvania in 1789; served as house surgeon at St. Bartholomew's Hospital, 1794–1795; spent some time the following year in Edinburgh and returned to Philadelphia in 1800. He was physician to the Orphan Asylum and to the Walnut Street Prison for twelve years (1806–1818), and surgeon to the Philadelphia Almshouse. In 1816 he was elected professor of comparative anatomy in the University of Pennsylvania, and in 1822 established a private school in which he taught anatomy.

Through the good offices of John Fothergill, he was received as an apprentice pupil in St. Thomas's Hospital by Alexander Russell[1] (1715?–1768). Among his teachers were Joseph Else, surgeon, James Grieve[2] (d. 1773), and Mark Aikinside, the poet. After a period he repaired to Edinburgh where he graduated in 1765. Among his fellow students at Edinburgh were William Withering[3] (1741–1799), Thomas Percival[4] (1740–1804), John Morgan, and John Haygarth[5] (1740–1827). Shortly after graduation, Bard returned to

Fig. 68.—Samuel Bard. (From the author's collection.)

America where he was instrumental in founding the medical faculty of King's College, being elected to the professorship of the theory and practice of medicine in 1767. Three years later midwifery was added to his chair and he held the combined professorship until 1776. In his address at the first commencement held in 1769, Bard set forth the need for a properly organized and

[1] Alexander Russell, author of the *Medical History of Aleppo* (1756); fellow of the Royal Society, and physician to St. Thomas's Hospital.

[2] James Grieve, M. D., Edinburgh, 1752; physician to St. Thomas's Hospital; fellow of the Royal Society and of the Royal College of Physicians. Translated Celsus' *De Medicina* (1756).

[3] William Withering was a pioneer in the therapeutic use of digitalis and his *Account of the Fox-Glove* (1785) is a medical classic.

[4] Thomas Percival helped form a committee for the enforcement of proper sanitation in Manchester and was the earliest advocate of factory legislation. In 1803 he published his *Medical Ethics*.

[5] John Haygarth was physician to the Chester Infirmary from 1767 to 1798 when he moved to Bath. He was a fellow of the Royal Society of London and Edinburgh. His *Letter to Dr. Percival on Prevention of Infectious Fevers*, which was read before the Bath Literary and Philosophical Society in 1801, embodied the principles of isolation, ventilation and cleanliness. He was the first to distinguish the different types of fever by their period of incubation. His *Essay on the Power of the Imagination* (1800) was largely instrumental in exposing the Perkins' Tractor fraud.

duction of the hand into the uterus as more dangerous than "the most desperate case of labor left to nature." Nevertheless, he feels impelled to describe some procedures which, because of the midwife's inability to secure help, she may be compelled to manage of her own knowledge. To those who desire fuller information, he recommends "particularly" the writings of Charles White and Thomas Denman. He says:

"I take pleasure in acknowledging my obligations to those two most excellent writers, to the study of whose valuable works, I have been indebted for much improvement in my former practice, as well as many useful lessons which I have attempted to detail in this performance."

A
COMPENDIUM
OF THE THEORY AND PRACTICE
OF
MIDWIFERY,
Containing
PRACTICAL INSTRUCTIONS FOR THE MANAGEMENT OF
WOMEN
DURING PREGNANCY, IN LABOUR, AND IN CHILD-BED;
Calculated
To correct the Errors, and to improve the Practice, of
MIDWIVES;
As well as to serve as an Introduction to the
STUDY OF THIS ART,
For
STUDENTS AND YOUNG PRACTITIONERS.

By SAMUEL BARD, M. D.

NEW-YORK:
PRINTED AND SOLD BY COLLINS AND PERKINS,
NO. 189, PEARL-STREET.
1808.

Fig. 69.—Facsimile of the title page of *A Compendium of the Theory and Practice of Midwifery* by Samuel Bard, New York, 1808. (Crerar Library.)

He rather apologizes for not adopting more generally the teachings of Smellie whose works he says:

". . . . are in the hands of almost every practitioner in this country and more generally read than any other: but . . . Smellie certainly was not acquainted with all the resources of nature in their full extent. Having greatly improved the instruments of his day, he has described their use with great precision; and I own I am apprehensive that many of his readers may thereby be induced to suppose them equally safe in their hands, as they appear to have been in his—and hence be led to a more frequent use of them than modern practice has found necessary or safe."

Bard had evidently witnessed much mischief as the result of the careless and indiscriminate use of obstetrical instruments, particularly forceps, and his

In his introductory lecture delivered in 1825 before the students and faculty of the College of Physicians and Surgeons, Hosack stated that the student must become familiar with (*a*) the anatomy and physiology of the female, (*b*) the signs and symptoms of pregnancy, (*c*) natural and complicated labors, (*d*) obstetrical instruments and their application, (*e*) diseases to which parturient women are liable including puerperal fever, hemorrhages, convulsions, etc. The course numbered ten or twelve lectures.

John W. Francis (1789–1861), whose edition of Denman's midwifery was widely used in America, was one of the best known and learned of the New York obstetricians. He was a conservative both in practice and teaching. This we may trace primarily to the influence of Samuel Bard who had taken David Hosack as his assistant in the practice of midwifery, and had at an early date made him his successor. Francis was a student under Hosack and became his partner shortly after graduation (1811), giving special attention to midwifery and becoming professor of obstetrics and diseases of women and children in the College of Physicians and Surgeons in 1819. In 1826 with other members of the Physicians and Surgeons faculty—David Hosack, Valentine Mott[1] (1785–1865), William J. Macneven and Samuel Latham Mitchill[2] (1764–1831)—he assisted in organizing Rutgers Medical College and was appointed professor of obstetrics. His active teaching career closed with the abandonment of the Rutgers institution about 1830. Francis' early interest in literature probably deprived midwifery of extensive and valuable contributions from his pen. He was a school fellow of Washington Irving (1783–1859) and his New York home was the resort of authors and artists.

The most striking and forceful figure in New York midwifery was soon to appear in the person of **Gunning S. Bedford** (1806–1870), who was born in Baltimore. As a youth he had decided to study law, but coming under the influence of John Godman[3] (1794–1830), he changed his plans and entered upon the study of medicine, graduating from Rutgers Medical College in 1829. After two years of European study, he returned to the United States and for a time served as an instructor in the Charleston (South Carolina)

[1] Valentine Mott graduated from the medical school of Columbia College in 1806. After three years of study under Sir Astley Cooper (1768–1841) and in Edinburgh, he began practice in New York City. He was appointed professor of surgery in Columbia in 1811. After Rutgers College was discontinued (1830) he became professor of operative surgery in the New York College of Physicians. He spent seven years travelling in Europe (1834–1841) and upon his return became professor of surgery in New York University Medical College. He was famous for his ligation of blood vessels, particularly of the innominate artery two inches from the heart for an aneurysm of the right subclavian artery (1818).

[2] Samuel Latham Mitchill studied medicine under his uncle and Samuel Bard. He was appointed professor of natural history, chemistry and agriculture in Columbia College in 1792, resigning the position in 1810; he was also professor of botany from 1792 to 1795. He made many contributions to the advancement of botany and chemistry; was much interested in the projects of Fulton, of DeWitt Clinton, and of the furtherance of the Military Academy at West Point; assisted in the establishment of the Literary and Philosophical Society of New York.

[3] John D. Godman (1794–1830), born at Annapolis, was one of the most pathetic figures in American medicine. He secured his M. D. from the University of Maryland in 1818. He was a man of unusual ability and established the first medical journal to be published west of the Alleghenies subsequent to a short period of service as a professor in the Medical College of Ohio. He was a brilliant anatomist and writer of distinction. His early death from tuberculosis deprived American medicine of a promising figure.

wifery, and much more that could be retained. In the light of progress since his time, his many absurdities may be overlooked. All in all Bedford's book established a new high-water mark for midwifery manuals of utility.

Another American writer of real importance was **James D. Trask** (1821–1883) of Brooklyn, whose work on rupture of the uterus[1] is an extensive and valuable compilation. The literature had been searched with such care and the report set forth with such clearness as to stamp the writer as one of the important contributors to the field of American midwifery. Trask was for a few years professor of obstetrics and diseases of women in the Long Island College Hospital. In 1864 when Gunning S. Bedford resigned the chair of midwifery and diseases of women in the medical department of the New York University, Trask was offered the position, but did not accept it. Trask's *Statistics of Placenta Praevia* was awarded the prize for 1855 by the American Medical Association and appeared in the *Transactions* for that year.[2] This was followed in 1861 by William Read of Boston, whose *Placenta Praevia; its History and Treatment*[3] was a most comprehensive review of the condition.

Although the medical department of Harvard College was established in 1782, it was not until the autumn of 1815 that the professorship of midwifery was created and the first occupant of the chair appointed in the person of **Walter Channing**[4] (1786–1876). Channing was born in Newport, Rhode Island. He obtained his medical education at the University of Pennsylvania, graduating M. D. in 1809. Soon thereafter he sailed for England and pursued his studies in Edinburgh and London, giving special attention to midwifery. In 1812 he returned to Boston where he commenced the practice of medicine with midwifery as his special field. He was promptly appointed lecturer in Harvard Medical School and three years later (1815) was made professor, which position he held for nearly forty years. He was a member of the first staff of the Massachusetts General Hospital and of the Boston Lying-in Hospital. He took an interest in medical journalism and was one of the editors of the *New England Journal of Medicine and Surgery* when that journal became the *Boston Medical and Surgical Journal.* He will be recalled as a member of the Boston Society for Medical Improvement and as one who, through his case reports, stimulated Oliver Wendell Holmes to prepare his famous essay on the contagiousness of puerperal fever.

The story of the discovery of anesthesia need not be recited here. It should be noted, however, that Walter Channing promptly seized upon ether as a means of allaying the suffering incident to labor and published in Boston in 1848 *A Treatise on Etherization in Child-birth. Illustrated by five hundred eighty-one cases.* Shortly after the first public demonstration of the anesthetic properties of ether (October 16, 1846), Channing began to use ether cautiously in his obstetrical practice and issued a pamphlet on the subject in May,

[1] *A statistical inquiry into the causes, symptoms, pathology and treatment of rupture of the uterus. American Journal of the Medical Sciences,* 1848, vol. xv, p. 104; cont. p. 383.

[2] Vol. viii.

[3] *Library of Practical Medicine,* vol. xxiii, Philadelphia, 1861.

[4] He was the brother of the distinguished Unitarian divine, William Ellery Channing. The anecdote is related that on an occasion when he was mistaken for his clergyman brother, he retorted: "My brother preaches, while I practice."

following year he went to Philadelphia with a view to perfecting himself in anatomy, expecting to become associated with the faculty of Transylvania. His expectations were not realized, however, and he resumed general practice in Kentucky until 1837, when the Medical Institute of Louisville (Kentucky) was founded, in which institution he was appointed professor of obstetrics and of diseases of women and children. This position he held for nearly twenty years, sometime later becoming professor of diseases of women in the Louisville Medical College, retaining this position until his death in February, 1874. His chief work was his *Theoretical and Practical Treatise on Human Parturition*, 1844. This was later revised and published under the title *Principles and Practice of Obstetrics*, 1858. Miller's book was largely drawn from French sources, such as Dubois and Dugès, yet his practice was in accord with the principles of Burns and Hamilton. Nevertheless, he may be regarded as a progressive teacher, and was one of the earliest American obstetricians to employ anesthesia in midwifery. He was an early advocate of the use of caustic for such conditions as endometritis and erosions of the cervix, and held that inflammation of the endometrium was a frequent cause of abortion. In 1859 he was elected president of the American Medical Association.

William H. Byford (1817–1890), professor of obstetrics and diseases of women and children in the Chicago Medical College (Northwestern University), published in 1870 a manual on the theory and practice of obstetrics,[1] consisting of 448 pages. Byford's interest, as we shall later note, was largely in gynecology, and his book suffers somewhat in comparison with the thorough, well-nigh modern treatise of Gunning Bedford. From the standpoint of operative obstetrics, however, the text had a wide influence. Rather more space is given to operative obstetrics than one would expect in an elementary manual; nevertheless, the practice as set forth is that of an author who held advanced ideas on the application of surgery to pelvic diseases. Byford is remembered as one of the founders of American gynecology.

Byford studied medicine with Joseph Maddox and in 1838 began practice in Owensville, Indiana, and subsequently (1845) received his M. D. from the Ohio Medical College of Cincinnati. He was appointed professor of anatomy in the Evansville Medical College in 1850 and professor of the theory and practice of medicine two years later. In 1857 he accepted the chair of obstetrics and diseases of women in Rush Medical College, but in 1859 joined the group who were establishing the Chicago Medical College as professor of obstetrics and diseases of women, which position he held for twenty years. In 1879 he returned to Rush as professor of gynecology. He was a founder of the American Gynecological Society and at one time was editor of the *Chicago Medical Journal* (later the *Chicago Medical Journal and Examiner*).

Henry T. Byford, the son of William H. Byford, was born in Evansville, Indiana, in 1853. He received his M. D. from the Chicago Medical College (Northwestern University) in 1873. He was one of the founders of the Chicago Post-Graduate Medical School and from 1892 to 1913 was professor of gynecology in the College of Medicine of the University of Illinois; since 1913 he has been professor emeritus of gynecology. He is the author of *Manual of Gynecology* (Philadelphia, 1895) and joint-author with his father of *Prac-*

[1] *A Treatise on the Theory and Practice of Obstetrics.* 1st edition, 1870, p. 255.

Institution[1] John Delamater (1787–1867) was appointed professor of pharmacy, materia medica and obstetrics in 1826; at the Medical College of South Carolina[2] Thomas G. Prioleau was appointed professor of obstetrics and diseases of women and children; at Jefferson Medical College,[3] F. S. Battie was professor of the institutes of medicine and midwifery; at the Medical School of the Valley of Virginia,[4] John G. Cooke was professor of physic and obstetrics; at the Washington Medical College,[5] W. M. Handy was professor of obstetrics; and at Rush Medical School[6] John Evans (1824–1897) was professor of midwifery and diseases of women and children.

Hospitals, dispensaries and clinics played a vital rôle in the progress of medicine and surgery and in medical education. The Pennsylvania Hospital, organized in 1751, was in full operation in 1756, and the lying-in wards were opened in the spring of 1803; the Philadelphia Dispensary was established in 1786; the lying-in wards of the Philadelphia Almshouse were opened in 1802; the Philadelphia Preston Retreat (Maternity) in 1835; and the Philadelphia Woman's Hospital in 1861. In New York City the New York Dispensary and the New York Hospital were opened in 1791, the latter having been rebuilt; the New York Lying-in Hospital was founded in 1798; Bellevue Hospital in 1816; the New York Infirmary for Women and Children was organized by Elizabeth Blackwell (1821–1910) in 1853; the Woman's Hospital of the State of New York in 1855 by Marion Sims; and the Sloan Hospital for Women (Sloan Maternity) dates from 1888. In Boston the Massachusetts General Hospital was founded in 1811, the Boston Lying-in Hospital in 1832, and the New England Hospital for Women and Children in 1862. The New Orleans Charity Hospital was organized in 1786. It will be noted that at a fairly early period hospitals and dispensaries began their essential service to the sick. Most of them served as important centers of teaching and to the Woman's Hospital of New York, where Marion Sims was followed by Thomas A. Emmet, we may trace many of the important world advances in gynecology.

Despite the interest in midwifery and the recognition of the importance of special teaching in this field, but few contributions to the advancement of the science of obstetrics had emanated from America. A few early instances of the recognition of ectopic pregnancy with examples of unparalleled resourcefulness on the part of early physicians and surgeons have already been mentioned. A contribution of note is that published in the *Medical Repository*[7] in a letter from John Stearns (1770–1848) of Saratoga County, New York, to Mr. S. Akerly, dated Waterford, January 25, 1807, in which Dr. Stearns gives an account of the therapeutic use of ergot,[8] which he calls *pulvis parturiens*. The letter states that he has used this preparation for several years:

> "It expedites lingering parturition, and saves to the accoucheur a considerable portion of time, without producing any bad effects on the patient. The cases in which I have

[1] Established at Pittsfield, Massachusetts, in 1823.
[2] Established at Charleston, South Carolina, in 1824.
[3] Established at Philadelphia in 1825.
[4] Established at Winchester, Virginia, in 1826.
[5] Established at Baltimore, Maryland, in 1827.
[6] Established at Chicago in 1843.
[7] Second hexade, vol. v, 1807.
[8] In June, 1813, Dr. Oliver Prescott in a communication to the Massachusetts Medical Society pointed out the value of ergot in postpartum hemorrhage.

essay, the title of which is, 'Difficult Labors and Their Treatment,' and that upon opening the sealed package accompanying the paper, it was found that Dr. *M. B. Wright, of Cincinnati was the author.*"

In his essay Wright does not describe cephalic version as a new procedure, but says that it was recommended by Hippocrates and was attempted in many cases where the head did not present. He notes that from the time of Paré, podalic version has been the method of choice in malpresentations. He further notes that Professor R. P. Flamant (1762–1832), of Strassburg, called the attention of the profession to the utility of cephalic version, and quotes Paulin Cazeaux (1808–1862), who in turn quotes Flamant, as favoring the performance of cephalic version. Wright cites Flamant as acknowledging

Fig. 70.—Marmaduke Burr Wright. From the *Ohio St. Med. Soc. Tr.*, 1854, vol. ix, p. 59.

that his procedure seldom succeeds and says that Cazeaux believes that most of the plans for cephalic version should be rejected. Wright describes his plan as follows:

"Suppose the patient to have been placed upon her back, across the bed, and with her hips near its edge—the presentation to be the right shoulder, with the head in the left iliac fossa—the right hand to have been introduced into the vagina, and the arm, if prolapsed, having been placed, as near as may be, in its original position across the breast. We now apply our fingers upon the top of the shoulder, and our thumb in the opposite axilla, or on such part as will give us command of the chest, and enable us to apply a degree of lateral force. Our left hand is also applied to the abdomen of the patient, over the breech of the foetus. Lateral pressure is made upon the shoulders in such a way as to give to the body of the foetus a curvilinear movement. At the same time, the left hand, applied as above, makes pressure so as to dislodge the breech, as it were, and move it towards the

"Dr. Wright's mode of manipulation in the case, was as follows: The patient being on her back, across the bed (in the usual position for turning) he introduced his right hand, passed a couple of loops of the prolapsed funis around the child's arm, and then returned it —converting it into a shoulder presentation. He then grasped the shoulder and thorax, and pushed the body of the child upwards and to the left side, in consequence of which the head was brought near the axis of the pelvis. He then relinquished his hold of the body and grasped the occiput—bringing it down so as to enable the head to engage."

Wright concludes his essay with the following statement:

"If our mode of performing cephalic version is sufficiently clear, in the description already given, it will be readily distinguished from others. We claim for it great importance, on the ground that it is easily executed—that the mother and foetus receive no injury—that there is little or no danger of subsequent displacement after the vertex has been fully adjusted—that, although it is most successful in recent cases, delivery may be accomplished after the membranes have been long ruptured—that it may be executed, after ineffectual efforts to bring down the feet.

"By an examination of plate 3 (Fig. 71), the different changes which take place in the position of the foetus, during cephalic version, from the return of the arm above the brim of the pelvis, to the first presentation of the vertex, will be observed. These sketches are not designed as faithful representations of every case of shoulder presentation and cephalic version, nor are they claimed as the exact changes which occur in any given case, but as outline illustrations of a general process."

J. Braxton Hicks (1825–1897) of London, whose name is also associated with cephalic version, published a description of his method in the *London Lancet* for July 14, 1860, and later published a more extended report in 1863 in the *Transactions of the London Obstetrical Society* (vol. v). Dr. Wright's maneuver consisted simply in changing a shoulder into a head presentation, while the maneuver of Dr. Hicks involved podalic version chiefly. Hicks' description of his management of cephalic version is as follows:

"Introduce the left hand into the vagina as in podalic version; place the right hand on the outside of the abdomen, in order to make out the position of the fetus, and the direction of the head and the feet. Should the shoulder, for instance, present, then push it with one or two fingers on the top in the direction of the feet. At the same time pressure by the outer hand should be exerted on the cephalic end of the child. This will bring down the head close to the os; then let the head be received upon the tips of the inside fingers. The head will play like a ball between the two hands; it will be under their command, and can be placed in almost any part at will. Let the head then be placed over the os, taking care to rectify any tendency to face presentation. It is as well, if the breech will not rise to the fundus readily after the head is fairly in the os, to withdraw the hand from the vagina, and with it press up the breech from the exterior."

By comparing this description with Dr. Wright's description quoted above, and with the figures taken from his 1854 prize essay, it will be noted that Wright apparently gives more credit to the function of the hand on the outside of the mother's abdomen, while as Theophilus Parvin says,[1] the rôle of the external hand in Hicks' maneuver is "never primary, only secondary and contingent."

Braxton Hicks states that the exact date of his first case he cannot give, but it was about the end of 1858, though the idea was conceived some months earlier. Dr. Hicks, on first hearing of Wright's maneuver, apparently read the case reports of Richardson and Walker but failed to give Wright's report

[1] *Memorial on Marmaduke B. Wright. Transactions of the American Gynecological Society*, vol. iv, 1879.

he attended lectures, numbering among his American student comrades David Hosack and Samuel Brown[1] (1769–1830). McDowell early came under the influence of Dr. John Bell[2] (1763–1820) who was giving *extramural* instruction in anatomy and surgery and to Bell he no doubt owed his firm

Fig. 72.—Ephraim McDowell, the "Father of Ovariotomy." (From the author's collection.)

grasp of surgical principles and his accurate knowledge of anatomy. Idealism and cool courage were his birthright from a line of distinguished pioneer ancestors.

The story of Mary Crawford,[3] the historic patient, as set forth in

[1] Samuel Brown, a graduate of Carlisle College, Pennsylvania; a student of Dr. Humphreys of Staunton, Va.; later at Edinburgh. He was the first medical professor of Transylvania University (1799), Lexington, Kentucky; professor of the theory and practice of medicine in the reorganized Transylvania medical faculty of 1819.

[2] John Bell, eleven years older than his brilliant brother, Charles (later Sir Charles) Bell, began lecturing to private pupils in a theater built for him in Surgeon's Square, Edinburgh in 1790. Until Charles Bell's removal to London in 1804 he assisted his brother, John, as demonstrator of anatomy. John Bell's love for truth led him openly to criticize the surgery of Benjamin Bell and the anatomy of Monro II, which brought down upon him a storm of criticism much of which was contained in a volume issued by James Gregory under the pseudonym of "Jonathan Dawplucker." Gregory's influence succeeded in excluding Bell from the Royal Infirmary although in after years Gregory was censured by the Royal College of Physicians, Edinburgh, for violations of truth and unprofessional conduct. The controversy and consequent waste of time and energy embittered Bell's life. He was a forceful, accurate teacher, much in advance of his time in the teaching of surgical anatomy. His chief works are *Principles of Surgery* (1801–1807), and *Anatomy of the Human Body* (1793–1803). He died in Rome after several years spent in travel in a vain search for health.

[3] Mary Crawford died at the age of seventy-nine years, thirty-two years after her operation.

page 216, we adverted to the cases of Dr. Macdowel, of Kentucky, published by Mr. Lizars of Edinburgh, and expressed ourselves as skeptical respecting their authenticity. Dr. Coates, however, has now given us much more cause for wonder at the success of Dr. Macdowel; for it appears that out of five cases operated on in Kentucky by Dr. M., four recovered after the extraction, and only one died. There were circumstances in the narratives of some of the first three cases, that raised misgivings in our minds, for which uncharitableness we ask pardon of God and of Dr. Macdowel of Danville. The two additional cases now republished (for it appears that the cases were published, though in a very unsatisfactory form, in the *American Eclectic Repertory*) are equally wonderful as those with which our readers are already acquainted."

Ephraim McDowell was born in Rockbridge County, Virginia, the son of Samuel McDowell (1735–1817) and Mary McClung McDowell. When Ephraim was thirteen years of age (1748) the family removed to Danville, Kentucky, then a frontier settlement. For more than a century the world of medical science has honored McDowell as the "father of ovariotomy." A beautiful monument marking his resting place in Danville was erected by the Kentucky State Medical Society and dedicated in 1879.[1] Samuel D. Gross, then in his seventy-fourth year, delivered the oration of dedication and no finer appreciation of the life and work of a pioneer surgeon can be found in all literature.

No text or lecture had set forth for McDowell's guidance the rules of surgical procedure; no hand had pointed the way. He sensed to the full that his skill and courage might mean life for that brave pioneer mother, Mary Crawford, and he realized only too keenly that his unwillingness to brave the surgical wilderness could only mean for her a lingering painful death.

New England's most distinguished surgeon and teacher, **Nathan Smith** (1762–1829), alike deserves remembrance for the rôle which he played in the development of ovariotomy.[2] Nathan Smith performed his first ovariotomy on July 5, 1821, the report of which, published in the *American Medical Recorder*,[3] is a model of conciseness. The patient was a Mrs. Strobridge who resided at Norwich, Vermont, where the operation was performed. There is no evidence whatever that Nathan Smith had ever heard of McDowell's procedure. We may regard, therefore, Nathan Smith's ovariotomy as a pioneer procedure.

To **James Marion Sims** (1813–1883) (Fig. 73) the world owes two outstanding achievements: the surgical victory over that distressing condition, vesicovaginal fistula, and the establishment of the Woman's Hospital of the State of New York. Sims was born in Lancaster, South Carolina, in 1813 and was graduated from South Carolina College in 1832. After his graduation, as was the custom of the day, he began his medical studies under a preceptor, later taking his first course of medical lectures at the Medical College of South Carolina in Charleston and his second course in Philadelphia at Jefferson Medical College, from which he graduated in 1835. He began the practice of medicine in his home town, later removing to Mount Meigs, Alabama, and thence in 1840 to Montgomery, Alabama.

The year 1845 was a memorable one and marked for Sims a turning

[1] The monument project originated with Dr. John D. Jackson of Danville and was continued to fruition by his pupil, Dr. Lewis S. McMurtry.

[2] See *Nathan Smith and Ovariotomy*. By Herbert Thoms. *International Abstract of Surgery*, 1929, vol. xlviii.

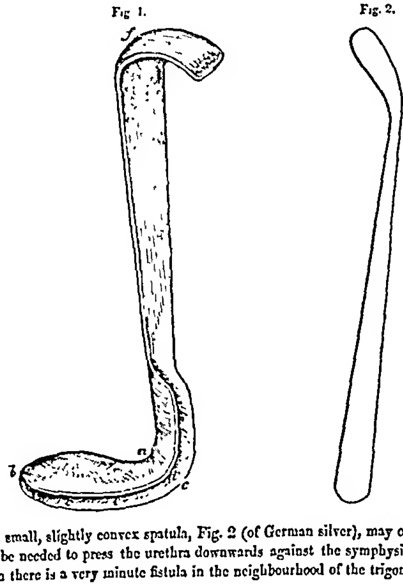
[3] Vol. v, 1822.

I want to make one more examination of your case.' She willingly consented. I got a table about three feet long, and put a coverlet upon it, and mounted her on the table, on her knees, with her head resting on the palms of her hands. I placed the two students one on each side of the pelvis, and they laid hold of the nates, and pulled them open. Before I could get the bent spoon-handle into the vagina, the air rushed in with a puffing noise, dilating the vagina to its fullest extent. *Introducing the bent handle of the spoon I saw everything, as no man had ever seen before.* The fistula was as plain as the nose on a man's face. The edges were as clear and well-defined, and distinct, and the opening could be measured as accurately as if it had been cut out of a piece of plain paper. The walls of the vagina could be seen closing in every direction; the neck of the uterus was distinct and well-defined, and even the secretions from the neck could be seen as a tear glistening in the eye, clear even and distinct, and as plain as could be. I said at once 'Why can not these things be cured? It seems to me that there is nothing to do but to pare the edges of the fistula and bring it together nicely, introduce a catheter in the neck of the bladder and drain the urine off continually, and the case will be cured.' . . . I felt sure that I was on the eve of one of the greatest discoveries of the day. The more I thought of it, the more I was convinced of it."

1852.] Sims, *Treatment of Vesico-Vaginal Fistula.* 65

Fig. 1 represents the speculum. When introduced and held properly, it causes no pain whatever. It is well enough to have two or three of different sizes, so as to be prepared for any case. The one ordinarily used by me is about 2½ inches from *a*, where it supports the sphincter, to its terminal extremity at *b*. Its concavity *c*, *c* serves to reflect a strong light down on the vagino-vesical septum, the seat of fistula. Its breadth from *d* to *e* is about ⅞ths of an inch, widening a little as it approaches the end, making it somewhat in the shape of a duck's bill. The handle is made strong and unyielding, because a considerable degree of leverage has to be exercised by it. The curve at *f*, being cushioned to prevent its hurting the forefinger, fits accurately over it. The whole instrument is made of German silver, the concavity being highly polished for reflecting the light.

Fig. 1. Fig. 2.



A small, slightly convex spatula, Fig. 2 (of German silver), may occasionally be needed to press the urethra downwards against the symphysis pubis, when there is a very minute fistula in the neighbourhood of the trigonus vesi-

Fig. 74.—Reproduction of a page from Sims' original report, *American Journal of the Medical Sciences*, 1852, vol. xxiii.

Sims immediately proceeded to devise instruments necessary for the operation. He ransacked the country for patients, told his fellow physicians of his discovery, and collected some six or seven cases. He built another story on his improvised hospital, which gave him sixteen beds—four for attendants and twelve for patients—and offered to keep the negro patients free of charge. Late in 1845 he began his operations. Failure after failure resulted, only partial closures being secured. Finally, he hit upon the idea of using suture

"Lecture on the Necessity of Organizing a Great Hospital in this City for the Diseases Peculiar to Females. The undersigned will deliver a lecture on this subject at the Stuyvesant Institute, No. 659 Broadway, on Thursday evening, the 18th inst. at 8 o'clock. The medical profession and the public are respectfully invited to attend. J. Marion Sims, M. D., 77 Madison avenue."

Stuyvesant Hall was well filled. Sims' plea could not be ignored, and as a result a committee on ways and means was appointed, made up of Drs. J. W. Francis, Valentine Mott, Alexander H. Stevens, Horace Green, J. Marion Sims, Mr. Peter Cooper, and Hon. Erastus C. Benedict. Largely as the result of the interest of influential New York women who actively supported Sims' project, the hospital was formally opened[1] in a rented building[2] June 2, 1855, and was subsequently chartered by the legislature of 1857–1858 as the Woman's Hospital of the State of New York.

With the opening of the Woman's Hospital, Sims' position as a leader in world gynecology was definitely established. His subsequent foreign travel and residence did much to advance the science of gynecology in many European centers. The Woman's Hospital of the State of New York, as from the beginning, continued its mission of healing and education—training many of the leaders in American gynecology.[3]

Prior to Sims, favorable results in operations for the repair of vesico-vaginal fistula were incidental rather than the result of a logical and rational method of procedure.[4] Sims' great contribution may be stated in his own words:

"I conceive that I may claim originality: 1st. For the discovery of a method by which the vagina can be thoroughly explored, and the operation easily performed.

"2d. For the introduction of a new suture apparatus, which lies imbedded in the tissues for an indefinite period without danger of cutting its way out, as do silk ligatures.

"3d. For the invention of a self-retaining catheter, which can be worn with the greatest comfort by the patient during the whole process of treatment."[5]

A bronze statue of J. Marion Sims was unveiled in Bryant Park, New York City, in 1894.

Following Marion Sims there occurred in American gynecology an extraordinary development in plastic surgery at the hands of **Thomas Addis Emmet** (1828–1919) (Fig. 75). Emmet was Sims' first assistant in the newly founded New York Woman's Hospital and continued as his great admirer and faithful collaborator. In Emmet's autobiographical sketch published in the proceedings of his seventy-seventh birthday dinner, New York, 1905, he says:

"I have also attempted to express my great obligation to my old friend Dr. J. Marion Sims, with whom, during our joint service of five years and a half at the Woman's Hospital, my relations were as close as that of a son."

[1] The address was delivered by John W. Francis.

[2] 83 Madison avenue.

[3] T. Gaillard Thomas, Randolph Peaslee, Emil Noeggerath and George Gray Ward.

[4] Ingenious methods which occasionally succeeded had been earlier proposed by Pierre-Joseph Desault (1744–1795), by Dr. Hobart of Cork, *Fistula between the bladder and vagina cured*, with case report in the *London Medical and Physical Journal*, 1825; by George Hayward (1791–1863), *Case of vesico-vaginal fistula, successfully treated by an operation*, *American Journal of the Medical Sciences* (vol. xxiv), 1839; and Joseph Pancoast (1805–1882) of Philadelphia in the *Medical Examiner*, 1847 (n.s., vol. iii).

[5] *American Journal of the Medical Sciences*, 1852, vol. xxiii.

he believed that Sims failed to grasp the great importance of the advances in plastic surgery which he (Emmet) had made. In one of these letters, Emmet says:

"It may seem a strange announcement but Dr. Sims knew nothing about plastic surgery as I practiced it. He gave us the speculum, silver wire and some of the most useful instruments and may in time have reached the point where I branched off, if he had not gone to Europe. But I first introduced the use of scissors instead of the knife and I believe I invented the shape of all in use. Dr. Sims never cut up a flap to free the edges but he dilated the vagina with glass plugs as Bozeman did and he could not close a vesico-vaginal fistula unless the edges came together without traction, and when he had such a case I have never seen his work equalled. For myself I care nothing and would rather give him more credit than was due him, but as part of the history of surgery the truth may as well be placed on record. When I published my little book on Vesico-Vaginal Fistula, the work I then described was as new to him as to any other member of the profession and I have some where among my papers a most enthusiastic letter from him after he had read the work. There was nothing mean in Sims' nature and he always tried to give me full credit."

Emmet's *Vesico-Vaginal Fistula from Parturition and Other Causes* was published in 1868. Of this contribution the *London Lancet* says:[1]

"The results of the numerous cases (seventy-five) related are in the highest degree honorable to Dr. Emmet's skill as an operator, and also to American surgery."

His *The Principles and Practice of Gynecology* appeared in 1879 and went through three editions within fifteen months. All three editions were republished in London; a translation into German was published at Leipzig and a French translation in Paris. Of *The Principles and Practice of Gynecology*, Emmet says:

"It was published, unfortunately, just before the full development or adoption of the aseptic treatment as applied to abdominal surgery."

Thomas Addis Emmet was born in Charlottesville, Virginia. He attended the University of Virginia for one year, thereafter graduating from Jefferson Medical School in 1850. He was surgeon to the Woman's Hospital of New York from 1862 to 1900 and was one of the founders of the American Gynecological Society and president in 1882.

Another surgical procedure based upon sound reasoning was that proposed by Robert Battey (1828–1895) of Rome, Georgia, and published in the *Atlanta Medical and Surgical Journal* for September, 1872. Battey's operation was designed to "establish at once the change of life for the effectual remedy of certain otherwise incurable maladies."

In the first case cited by Battey there was a congenital absence of the uterus. He says:

"Nature had provided ovaries performing their natural function in full vigor, but no womb to respond by the proper issue of the menses. I said to myself, if she could be relieved of her ovaries, the balance would at once be restored; the menstrual molimen would cease; the violent strain upon the heart would be at an end; there might be hope for her."

In the case which he operated, the woman's health was restored and all the symptoms complained of disappeared.

[1] February 20, 1869.

courses of lectures at the Jefferson Medical College, where he was graduated in 1857. In 1859–1860 he visited Europe, spending most of his time in the hospitals in Paris. In 1872–1875 he was professor of obstetrics at the Atlanta Medical College. He was editor of the *Atlanta Medical and Surgical Journal*, 1873–1876. His death occurred November 8, 1895. He was president of the Medical Society of Georgia in 1876 and of the American Gynecological Society in 1888, and held membership in numerous foreign obstetric and gynecological societies. A monument to Dr. Battey was unveiled in Rome, Georgia, in 1921, the dedicatory address being given by Dr. Howard Kelly of Baltimore.

The use of **electricity in gynecology** began with the work of Auguste Tripier[1] (b. 1830) in France, who in 1860 described bipolar faradization. He was followed by his pupil, Georges Apostoli[2] (1847–1900), whose influence rapidly spread to America and gave rise to numerous works on the application of electricity to gynecology. Among Apostoli's most ardent American disciples were Paul F. Mundé[3] (1846–1902), George Julius Engelmann[4] (1847–1903), and Egbert Henry Grandin[5] (b. 1855) among gynecologists, and Alphonso D. Rockwell[6] (b. 1840) and G. Betton Massey[7] (1856–1927) among electrotherapeutists. As a result, the use of electricity in diseases of the female pelvis swept over and well-nigh engulfed American gynecology. In many clinics Apostoli's plan was the method of choice in the treatment of uterine fibroids, "salpingo-ovaritis," and numerous inflammatory conditions. Several monographs on electricity in gynecology were published in America,

[1] Auguste Tripier, French physician and pioneer investigator on the therapeutic effects of electricity, published numerous monographs.

[2] Georges Apostoli, the leader of gynecological electrotherapy in France, studied at the School of Military Medicine at Strassburg. After ten years of army service, chiefly in Algeria, he returned to Paris to work under Tripier. Through the thesis of his pupil Lucien Carlet (b. 1859)—*Du Traitement Électrique des Tumeurs Fibreuses de l'Utérus (d'après la Méthode du Dr. Apostoli)*, Paris, 1884, his treatment of uterine fibroids became known.

[3] Paul F. Mundé, M. D. Harvard, 1866; Master of Obstetrics, University of Vienna, 1871. He was one of the founders of the American Gynecological Society, and served as treasurer, 1876–1883, vice-president, 1885, and president, 1898.

[4] George Julius Engelmann received his M. D. from Berlin in 1871. He was one of the founders of the American Gynecological Society, and served as president in 1900. His father, George Engelmann (1809–1874), achieved great distinction not only as a physician, but as a botanist.

[5] Egbert Henry Grandin received his M. D. from Harvard in 1880. He was gynecologist to the Columbus and the French hospitals (New York) and obstetrician to the New York Maternity Hospital. He was a member of the New York Academy of Medicine and served as vice-president from 1886 to 1899.

[6] Alphonso David Rockwell pursued a collegiate training at Kenyon College (Gambier, Ohio), receiving his M. D. from Bellevue Hospital Medical College in 1864. He was surgeon to the Sixth Ohio Cavalry from 1864 to the close of the war. In 1865, he located in New York and made a specialty of nervous diseases and electrotherapeutics. He is a fellow of the New York Academy of Medicine. He recently celebrated his ninety-second birthday at his home in Flushing, New York.

[7] George Betton Massey received his M. D. from the University of Pennsylvania in 1876. In 1880 he began to specialize in electrotherapeutics. He served as assistant physician (1878–1879) and electrotherapeutist (1881–1887) to the State Hospital for Insane (Danville, Pennsylvania); physician in the gynecological department of Howard Hospital (Philadelphia) 1887–1898; former president and fellow of the American Electrotherapeutic Association.

was one of the earliest to study the surgical removal of uterine fibroids and his paper entitled, *The surgical treatment of fibrous tumours of the uterus, heretofore considered beyond the resources of art*,[1] was awarded the prize by the American Medical Association for the year 1853. Fourteen case reports accompanied Atlee's essay, and when one considers the period in which his operations were performed, not only the ingenuity of the procedure, but the favorable results indicated appear remarkable. While few fibroids were removed in their entirety (the vaginal route was employed), yet this early attack upon uterine tumors may well be regarded as a gynecological landmark.

In 1876 the first volume of the *Transactions of the American Gynecological Society* appeared, and the progress of American and world gynecology has

Fig. 76.—Washington L. Atlee. From *Amer. Gynec. Soc. Tr.*, 1878, vol. iii, p. 372.

since that time been clearly reflected in the pages of this long series of annual volumes. One has but to peruse the author index to note the names of many universally known leaders in surgical progress. Prior to the organization of the American Gynecological Society and for many years subsequent thereto, gynecology as an academically recognized specialty was vigorously opposed, particularly by general surgeons. Nevertheless, gynecological societies had been organized in many of the larger centers, the first of which was the Gynecological Society of Boston, established in 1869. The *Transactions* published by this society, led by Horatio Robinson Storer, exerted a wide influence. In 1870 the American Medical Association by resolution urged the separation of midwifery from gynecology and the establishment of individual chairs in

[1] *Transactions of the American Medical Association*, vol. vi, 1853.

view, but attempted to explore the cavity of the uterus by means of a scoop which he termed a "curet." Recamier was followed by Jacques Lisfranc, whose treatise on diseases of the uterus, *Maladies de l'utérus*, edited by Jean H. Pauly (1806–1854), was published in 1836. The uterine sound was first described[1] before the Academy of Medicine of Paris in 1828, by Samuel Lair, but it was nearly a generation later ere James Y. Simpson showed (1843) that the uterine sound could become in skilful hands a valuable diagnostic agent. About the same time the instrument was used by P. C. Huguier (1804–1873) of Paris and Franz Kiwisch (1814–1852) of Prague. According to Schröder the uterine sound was employed by Levret as early as 1771. The development of French gynecology was greatly stimulated in later years by Eugène Koeberlé (b. 1828) and Jules Péan (b. 1830).

Fig. 77.—Robert Gooch. (From the author's collection.)

With the beginning of the nineteenth century many of the texts on midwifery published in England contained chapters or sections dealing with diseases peculiar to women. Earlier than this **Henry Manning** had published what might have been termed a medical gynecology entitled, *A Treatise on Female Diseases* (London, 1771). This work dealt with the disorders of menstruation, inflammation of the uterus and vagina, scirrhous tumors of the uterus, abscesses, ulcers, malpositions of the uterus and diseases of the ovaries, and fallopian tubes. Apparently this early work of Manning was given but little serious consideration and it was not until the emphasis given to gynecology by James Blundell and Robert Gooch (Fig. 77) that widespread interest among English obstetricians and surgeons was aroused.

[1] *Nouvelle méthode de traitement des ulcères, ulcérations et engorgemens de l'utérus.*

operation, the danger of which it would scarcely increase. This operation would prevent subsequent impregnation.

"2. The extirpation of the healthy ovaries. This would probably be found an effectual remedy in the worst cases of dysmenorrhoea, and in bleeding from monthly determination on the inverted womb.

"3. The extirpation of the ovarian cyst in scirrhus, combined with dropsy, or in simple dropsy. 'This operation will, I am persuaded,' he says, 'ultimately come into general use, and if the British surgeons will not patronise and perform it, the French and American surgeons will.'

"4. The removal of a large circular piece of the cyst in ovarian dropsy when the sack itself cannot be extirpated.

"5. The removal of the cancerous womb when the ulceration first makes its appearance.

"6. Extirpation of the puerperal uterus when the Caesarean operation is performed, or when a patient is evidently sinking after rupture of the womb.

"7. In rupture of the bladder, lay open the abdomen, tie the bladder, discharge urine, and wash out the peritonaeum thoroughly by the injection of warm water."

Blundell's position on the extirpation of healthy ovaries antedates Battey and was severely criticized as "wild and extravagant." The *Medico-Chirurgical Review* says:

"In despite of all that has been written respecting this cruel operation, we entirely disbelieve that it has ever been performed with success, nor do we think it ever will."

Ovariotomy at the hands of Charles Clay (1801–1893), Lawson Tait (1845–1899) and Sir Thomas Spencer Wells was brought to an unusually high degree of perfection. **Charles Clay** is regarded in Great Britain as the father of ovariotomy. In 1845 he extirpated a fibroid uterus through an abdominal incision, thus antedating Eugène Koeberlé[1] of Strassburg who in 1863 removed the uterus for fibroids, operating 2 cases.

Lawson Tait, who is described as "aggressive, unconventional, dogmatic, and original," did six ovariotomies at the age of twenty-three when serving as house-surgeon at Wakefield. In 1870 he removed to Birmingham and in 1871 he was made a member of the staff of the Woman's Hospital, which position he retained until 1893. He was appointed professor of gynecology in Queen's College in 1887. His reputation as a gynecologist was world-wide, yet his disregard of conventions, of surgical asepsis and of the feelings of his colleagues, surrounded him with a mantle of fear which few were able to cast aside. In 1872 he removed the uterus for myoma and by 1878 had performed fifty ovariotomies with nineteen deaths, utterly disregarding antiseptic technic. He performed his first cholecystotomy in 1879. In his second fifty ovariotomies completed in 1880 there were but three deaths. In 1883 he first operated for ectopic pregnancy and by 1885 had achieved the enviable record of 139 consecutive laparotomies without a death. He was one of the founders of the British Gynecological Society.

Spencer Wells had studied at Leeds, with Stokes and Graves in Dublin and with Benjamin Travers in London. He was made a Fellow of the Royal College of Surgeons in 1844. His first ovariotomy was performed in 1858. He was surgeon of the Samaritan Free Hospital for Women in London, also to Queen Victoria's household. He was regarded as the leading student of ovarian diseases and as probably the safest operator for pelvic pathology. Quite in contrast with the character of some few of his colleagues, Wells

[1] Koeberlé will be recalled as a famous ovariotomist and as one of the earliest to advocate the use of the hemostatic forceps.

SECTION I

ANATOMY OF THE FEMALE GENITAL TRACT

CHAPTER I

ANATOMY OF THE FEMALE GENITALIA AND PELVIC SOFT PARTS[1]

By Barry Joseph Anson, Ph. D.

Chicago, Ill.

PELVIS

The pelvis, in the broadest meaning of the term, is the anatomical area bounded behind by the sacrum and the coccyx, and at the sides and in front by the innominate bones (Fig. 79; compare Figs. 91 and 92). The whole region is divided into an upper part, the greater pelvis (*pelvis major;* O. T., false pelvis[2]) and a lower part, the lesser pelvis (*pelvis minor;* true pelvis) by the margin of the *linea terminalis,* which, curving downward and forward, consists on either side of the upper border of the first sacral vertebra, the arcuate line of the ilium, and the pectineal line of the pubis.

The greater pelvis is the expanded portion of the entire cavity above the linea terminalis (Figs. 91 and 92). Posteriorly it is deeply notched on each side between the ilium and the lumbar vertebrae; laterally it is bounded by the iliac fossae on the inner aspects of alae; anteriorly, where the bony wall is deficient between the ilia, the boundary is furnished by the abdominal parietes.

The lesser pelvis is the contracted portion below and behind the linea terminalis. Since it is part of the pelvis concerned in childbirth, it will be the subject of our anatomical account. The lesser pelvis may be divided into an inlet, bounded by the superior circumference, an outlet, limited by the inferior circumference, and a cavity. The superior circumference forms the brim of the pelvis, and encloses the oval space termed the superior aperture (*apertura pelvis minoris superior*) which corresponds to the plane of the superior strait. The circumference of the inlet is formed by those eminences, mentioned above, which divide the whole pelvis into two portions, namely,

[1] Editor's Note: The illustrations in Dr. Anson's contribution are original drawings by W. Branks Stewart made from dissections prepared under the author's supervision by John Martin, Jr., and from coronal and sagittal sections. Carefully selected bodies of young nulliparae were used for this purpose. The relative size and location of the various structures has been determined with mathematical precision, after measurement. Because dissecting room material is subject to distortion incident to postmortem changes and the action of preservatives, observations have been made continuously in the operating room, at the time of pelvic operations, over a prolonged period of time, in order to determine the anatomical relationships of the pelvic viscera in the *living* subject. Appropriate modifications in the plates have been made to conform therewith.

[2] The anglicized form of the B N A (Basle Nomina Anatomica) terms will be regularly employed in naming anatomical structures, followed parenthetically by the proper Latin form and the older term whenever the latter is still in common use.

the anterior margin of the base of the sacrum behind, the arcuate and pectineal lines at the sides, and, in front, the continuation of the pectineal line of each half into the tubercle and the crest of the pubis. The inferior circumference forms the outlet of the pelvis, and is of very irregular outline. It includes the space called the inferior aperture (*apertura pelvis minoris inferior*), and lies in the plane of the inferior strait. It is bounded behind by the tip of the coccyx, at the sides by the ischial tuberosities, and in front by the pubic arch which is formed by the inferior rami of the ischium and the pubis as these converge from either side toward the pubic symphysis. Between the ischial tuberosity anteriorly and the coccyx and sacrum posteriorly the bony wall of the pelvis is incomplete, and the deficiency assumes the form of a deep notch to either side of the middle line. This wide interval is bridged across, and partially filled, by the sacrospinous ligament (*ligamentum sacrospinosum;* small or anterior sacrosciatic ligament) and the sacrotuberous ligament (*lig. sacrotuberosum;* great or posterior sacrosciatic ligament) which convert it into two foramina above and below the spine of the ischium, the greater and the lesser sciatic foramen respectively. The inferior margin of the sacrotuberous ligament thus assists in determining the shape of the pelvic outlet.

The cylindrical canal which ends above at the pelvic brim or inlet and below at the outlet is termed the cavity of the pelvis. This osseoligamentous space is clothed on its internal surface by a series of muscles and their investing fasciae (pages 250, 251) which considerably alter its form; on each lateral half these muscles are the piriformis and coccygeus posteriorly, the obturator internus laterally, and the levator ani inferiorly. The levatores ani, together with the coccygei, constitute a musculo-aponeurotic partition called the pelvic diaphragm, which separates the space of the pelvis above from that of the perineum below. The pelvis contains the bladder in the anterior part of the space, the rectum in the posterior, and, between these, the generative organs, comprising the uterus, vagina, and uterine appendages. The perineum is traversed by the terminal portions of these three organ systems—the urinary, digestive, and genital—and their orifices open below upon its surface (Fig. 80).

PERINEUM

The perineum is the anatomical region at the inferior end of the trunk between the thighs. It is, externally, a deep cleft when the thighs are approximated, but, when the latter are abducted, it becomes a broad lozenge-shaped area. Deeply (Fig. 79) it is limited in front by the pubic symphysis and the arcuate ligament, on each side by the inferior rami of the pubis and the ischium, the ischial tuberosity, and the sacrotuberous ligament, and behind by the sacrum and the tip of the coccyx. On the surface (Fig. 80), it is bounded in front by the mons veneris, which rests upon the pubis, behind by the gluteal region (buttock), and at the sides by the femoral region (thigh). In occupying the interval enclosed by the hip bones and the sacrum, it contains all of the structures situated within the pelvic outlet. Upon its surface terminate the urogenital tract and the alimentary tract, in front of and behind, respectively, an arbitrary transverse line joining the ischial tuberosities. The perineum as a whole may then be conveniently divided into an anterior urogenital triangle or region and a posterior anal triangle (region).

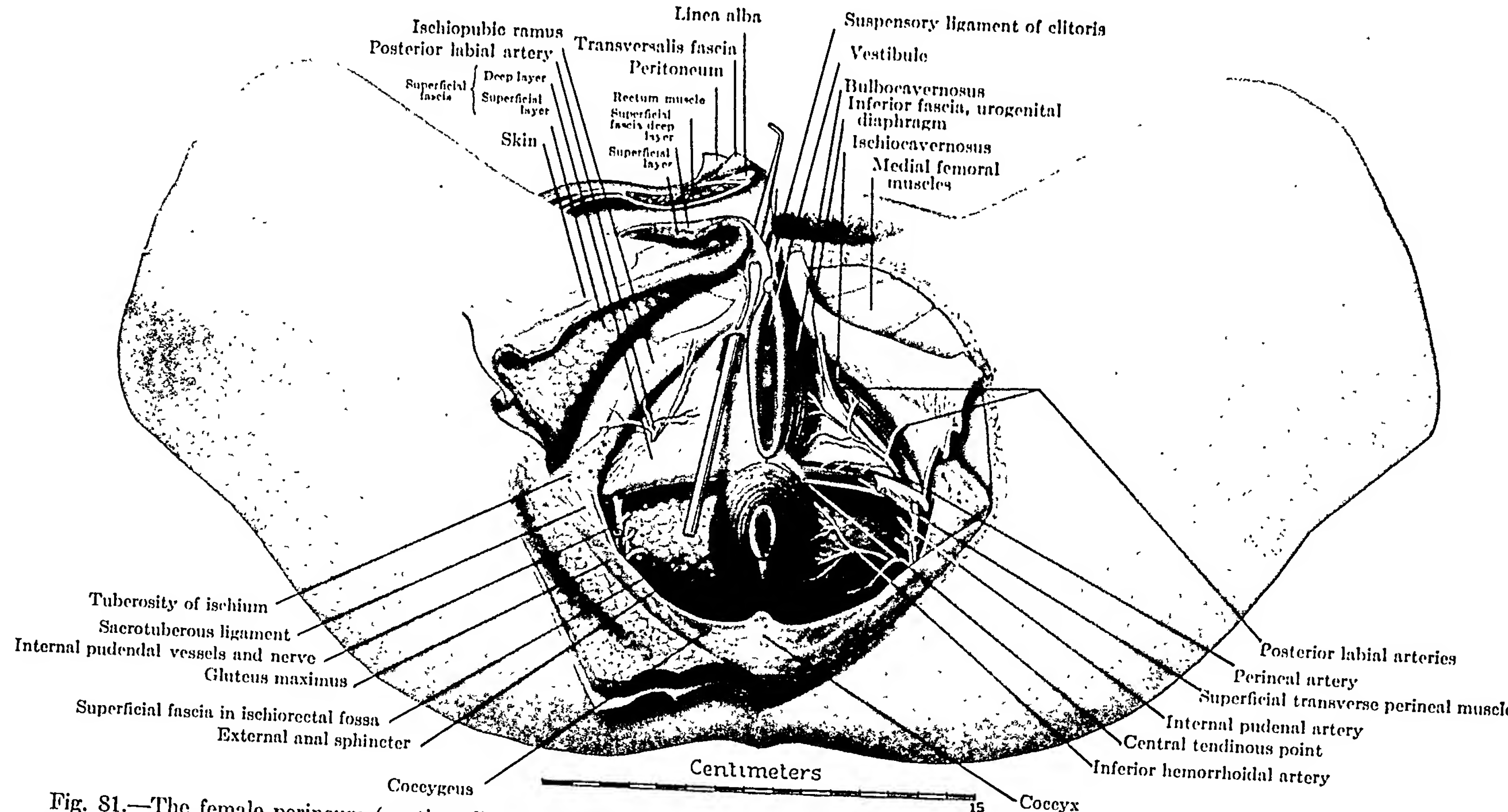


Fig. 81.—The female perineum (continued). On the right half of the urogenital triangle the superficial fatty layer has been turned aside to display the deep layer of the superficial fascia; the latter, on the left half, has been reflected to show the contents of the superficial perineal compartment.

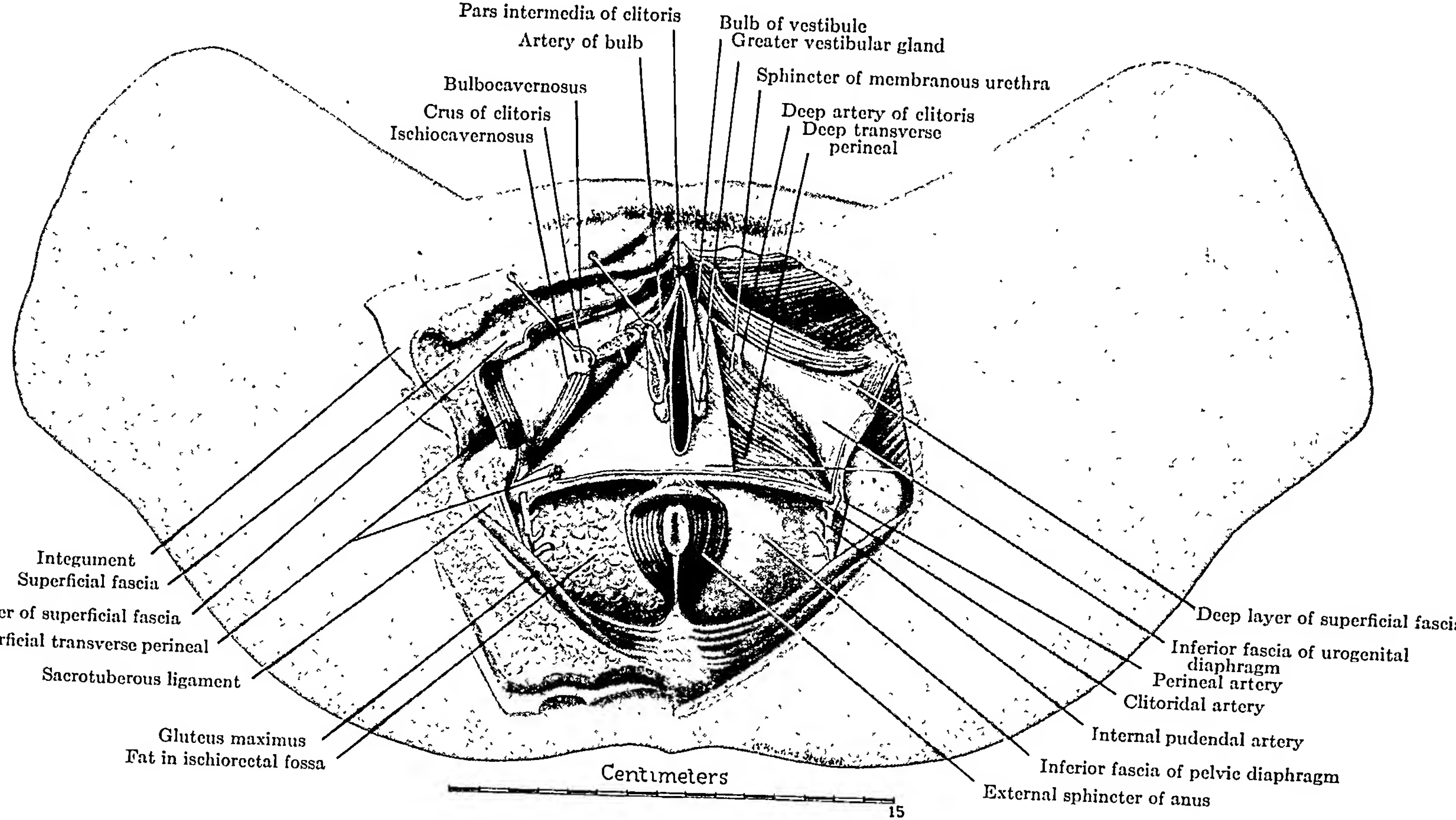


Fig. 82.—On the right half of the urogenital triangle the cavernous bodies in the superficial compartment have been exposed by partial removal of the superficial perineal muscles; on the left, the inferior fascia of the urogenital diaphragm has been reflected to show the musculature in the deep perineal compartment. In the anal triangle, on the left side, the superficial (fatty) tissue has been removed from the ischiorectal fossa.

To its mass the external sphincter and the levator ani contribute the muscle fibers. The soft adipose fibrous tissue in the two ischiorectal fossae—of which tissue the anococcygeal body may be considered a modified nodular portion—is continuous with the general fatty pannicle of the gluteal and of the femoral regions (Fig. 80). As the layer is continued outward toward the medial side of the thighs and over the tuberosities of the ischia, it undergoes further modification: the fibrous content becomes tough and stringy, dividing the contained fat into separate lobules, and fastening the skin to the subjacent bone and deep fascia.

Urogenital Region

External Anatomy.—The urogenital part of the perineum contains the urethral opening and the external organs of generation (*partes genitales externae*). To the latter group of structures is applied the collective term pudendum (*pudendum muliebre; vulva*); it comprises the greater lips and the genital parts which lie between them, namely, the lesser lips, the body and glans of the clitoris, and the vaginal orifice. The pudendum forms a keel-shaped eminence (Fig. 80), wider in front than behind, extending from the pubes to a point in front of the anus, and enclosing a deep median cleft.

Greater Lips and Commissures.—Each greater lip (*labium majus pudendi*) is homologous to a half of the scrotum in the male, and the line of the vestibular or pudendal cleft between the two lips corresponds in position to the scrotal raphe. Since the labia majora are in contact with each other, they are usually the only visible parts of the external genitalia. The labia majora are rotund folds of integument the size and shape of which depend upon the amount of underlying fatty tissue. They usually measure about 8 cm. in length and 3 cm. in width. They come together over the pubis symphysis to form a prominent median cushion-like elevation, the anterior commissure (*commissura labiorum anterior; mons veneris* or *mons pubis*), and, narrowing as they go posteriorly, are connected again to form a much less distinct posterior commissure (*commissura labiorum posterior*). They are limited lateralward by furrows in the skin, and medially form the boundaries of the vestibule. Their outer convex surface is covered by ordinary skin, hair-clad, and provided with numerous sebaceous glands; the inner surface, which lies against that of the opposite labium, possesses a more delicate skin with large sebaceous follicles. The subcutaneous tissue is rich in fat, and contains smooth muscle fibers which are homologous to the more abundant dartos tunic of the male.

Lesser Lips.—Each lesser lip (*labium minus pudendi; nympha*) is a cutaneous fold lying medial to the labium majus. Together the labia minora enclose the vestibule. In the young they are commonly concealed within the fissure between the approximated labia majora; in the old and in multiparae they are not infrequently pendulous and visible externally. These paired folds are parallel and internal to the labia majora, but shorter and very much thinner than the latter; they attain their maximum height near their anterior ends. They converge anteriorly as they reach the clitoris, and each terminates by splitting into two even thinner folds; the medial divisions join the sides of the clitoridal glans to form the frenum (*frenulum clitoridis*); the lateral divisions arch hoodlike over the glans, and constitute the female prepuce (*praeputium clitoridis*). The labia minora diminish in size posteriorly,

In young subjects it occasionally occurs as a complete and imperforate septum; sometimes it is entirely wanting. Usually, however, it is present and displays a small aperture near its midportion which varies in size from pin-point caliber to an orifice crescentic or circular, admitting a finger's tip. When ruptured in coitus, the opening becomes enlarged, and the fold remains only as a notched or even fimbriated annular membrane; the marginal excrescences of the fold (*carunculae hymenales; carunculae myrtiformes*) after labor become further reduced to nodular projections.

Deeper Anatomy.—*Superficial Fascia.*—The superficial perineal fascia, whose modifications in the anal region have been described, undergoes a further alteration in the urogenital triangle by dividing into two definite layers, a superficial fatty stratum and a deeper membranous one (Fig. 80). It is therefore similar in arrangement to the double-layered abdominal fascia with which it is directly continuous. The superficial of the two perineal layers is part of the general fatty pannicle or superficial fascia covering the entire body, and like it is of a loose areolar texture with a considerable quantity of fat in its meshes. Posteriorly it is continuous with the adipose pad filling the ischiorectal fossa on each side of the anus; anteriorly, it shares in the formation of the labia majora and the mons veneris and is carried upward in front of the pubes (Fig. 81) as the superficial fatty layer (Camper's fascia) on the lower portion of the anterior abdominal wall. Where it covers the labia, fat becomes somewhat scarcer in its meshes, giving place to a thin layer of involuntary muscular fibers which represent those of the dartos tunic in the scrotum of the male. *Lateralward the superficial layer leaves* the perineum to become continuous with the outer fatty layer on the thighs.

The deep layer of the superficial perineal fascia (Colles's fascia) is of a wholly different nature. It is a thin but strong aponeurotic layer, which, except for its continuity in front with the deep layer of the superficial abdominal fascia (Scarpa's fascia) is limited to the anterior half of the perineum, ending behind at a transverse line joining the ischial tuberosities. At the sides of the anterior triangle this dense membranous stratum ends sharply by becoming firmly attached to the ischiopubic rami and the ischial tuberosities. In the middle line it is divided by the cleft of the vestibule; behind it marks the line of division between the anal and urogenital portions of the perineum; here it curves upward around the superficial transverse perineal muscle to join the fascia of the urogenital diaphragm.

Superficial Perineal Compartment.—The deep layer of the superficial perineal fascia, in attaching itself to the margins of the bones at the pelvic outlet, forms the floor of a definite pouch in the anterior or urogenital part of the perineum (opened in left half of Fig. 81); and in becoming continuous posteriorly with the urogenital diaphragm, the same fascia forms the hinder boundary of this triangular pouch which has been conveniently named the superficial perineal compartment (superficial, or anterior, intra-aponeurotic space, or superficial perineal interspace). The roof, or superior boundary, is the inferior fascia of the urogenital diaphragm. Anteriorly the compartment is open in the sense that the contained space is continuous upward onto the abdomen, across the front of the pubic symphysis, with an areolar-tissue interval situated between the deep layer of the superficial fascia (Scarpa's) and the deep fascia covering the muscles of the anterior abdominal wall (note probe in Fig. 81). It is through this stratum that an exudate, or blood,

The glans of the clitoris fits over the rounded ends of the conjoined corpora cavernosa; yet, it is not part of them, but rather an extension forward of the cavernous tissue of the vestibular bulbs, to which it is united under the body of the clitoris, by a slender elongate mass of erectile tissue, the *pars intermedia*. The bulbs divide from this point of union anteriorly, and pass backward and outward, with their medial surfaces in contact with the wall of the vestibule at its point of junction with the vagina. The separation of the bulbar mass into bilateral halves which surround the vestibule, constitutes the dissimilarity between the bulb of the vestibule (female) and the bulb of the urethra (male). If the halves of the bulb in the female were brought into contact with each other, so that the vestibular outlet were closed and the urethra made to traverse the bulb, the body, the intermediate mass, and the glans of the clitoris, thereby the *corpus cavernosum urethrae* of the male would be reconstructed; this is tantamount to saying that the four portions of the medial mass of erectile tissue in the female find developmental and morphological equivalents in the male.

Each bulb (*bulbus vestibuli*) is an oblong mass of erectile tissue, about 4 cm. long and 0.5 cm. wide. They are rounded behind, where they are in close contact with the greater vestibular glands, and pointed in front where, narrowing considerably, they pass to the sides of the urethra and unite near the body of the clitoris. Behind, the medial surface of each is closely related to the lateral wall of the vaginal entrance, and may occasionally extend as far backward as the posterior wall of the vagina. Below, each extends to the base of the labium, and above is in contact with the inferior fascia of the urogenital diaphragm.

Central Tendinous Point.—The cavernous bodies in the superficial perineal compartment are invested by thin sheets of musculature. The muscles which cover the bulbs, together with superficial transverse perineal muscle and the levator and external sphincter of the anus, converge to a fibrous point in the middle line of the perineum between the posterior labial commissure and the anus, and at the posterior limit of the superficial perineal compartment (Fig. 81). The so-called point is actually a common tendon of attachment for the several muscles which compose it. The structures at this tendinous point contribute to a neighboring and less definite wedge-shaped mass of fibrous and muscular tissue which lies between the rectum and the vagina, called the perineal body. This body holds a relation to the front of the rectum comparable to that of the anococcygeal body behind.

Superficial Perineal Muscles.—The perineal muscles in the superficial group are arranged in three bilateral pairs, and are situated between the superficial fascia and the urogenital diaphragm, in association with the erectile bodies of the clitoris (Figs. 81 and 82). The three muscles in either half of the superficial perineal compartment form the boundaries of a triangle, being placed in transverse, in oblique, and in sagittal plane.

The posterior component, the superficial transverse perineal muscle (*transversus perinei superficialis*), lies along the base of the urogenital triangle. It arises, as does the larger but homologous muscle in male, by tendinous fibers from the medial and forepart of the tuberosity of the ischium. As a narrow rounded slip it runs medialward to end, between the anus and the vestibule, by fusing with its fellow of the opposite side and blending with other fibrous insertions which contribute to the central point of the perineum.

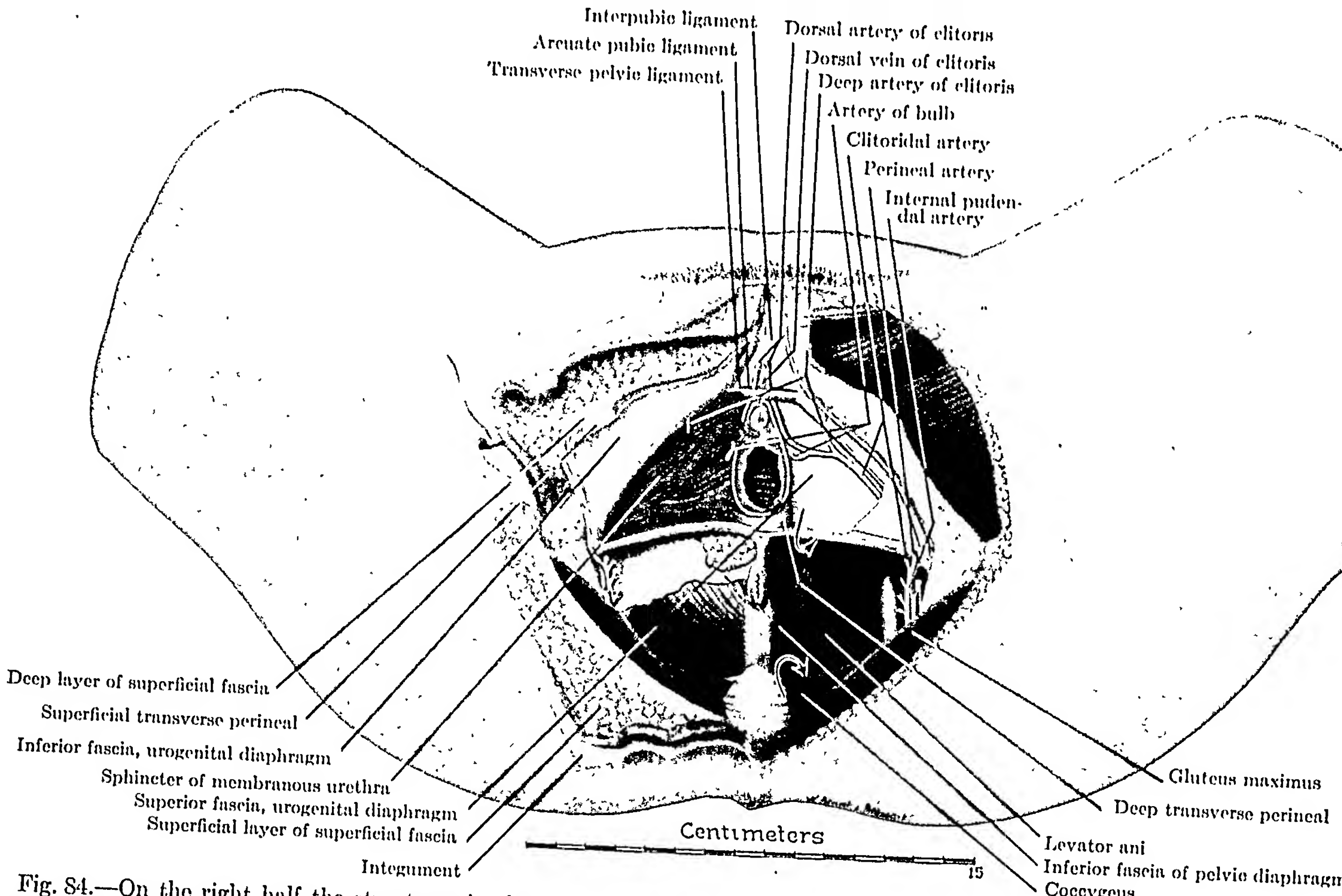


Fig. 84.—On the right half the structures in the superficial perineal compartment have been turned outward to show the muscles in the deep compartment; on the left, the muscles have been removed to show the vessels which supply the cavernous bodies. In the anal triangle the inferior fascial layer of the pelvic diaphragm has been partially cut away. Arrows point to the anterior and the posterior recesses of the ischiorectal fossa; some fatty tissue remains in the right fossa.

is 1 to 1.5 cm. below the pubic symphysis, and the anterior limit of the vaginal opening is about 1 cm. further removed from the symphysis. On either side the base of the fascial compartment is pierced by the internal pudendal vessels and the pudendal nerves (Fig. 84), and in succession forward, by the branches of these to the erectile tissue of the bulb, the crus, and the glans (hereinafter, pp. 245, 249).

Deep Perineal Compartment.—The deep perineal compartment (interspace or intra-aponeurotic space) is the pouch between the two layers of the deep fascia in the urogenital triangle of the perineum (opened in Fig. 84). It contains the deep transverse perineal muscle, the sphincter muscle surrounding the membranous part of the urethra and the pudendal vessels and nerves.

SPHINCTER MUSCLE OF THE MEMBRANOUS URETHRA.—This muscle (*m. sphincter urethrae membranaceae; compressor urethrae*) is enclosed between the fasciae of the urogenital diaphragm, and surrounds the entire length of the membranous portion of the urethra (Fig. 84). The innermost fasciculi form an uninterrupted ring of fibers which embrace the urethra. The external fibers have a bony origin, arising on each side of the perineum from the inner aspect of the ischiopubic ramus for a distance of approximately 2 cm.; the fibers are also attached to the apposed surfaces of the two fascial laminae of the diaphragm. As they approach the median plane, the anterior fibers pass in front of and behind the urethra, uniting with the muscle of the opposite side, or joining it in a tendinous raphe; the middle group of fibers is attached to the wall of the vagina, while the posterior ones may intermingle in the middle line or unite in a raphe. The muscle is a sphincter, serving to constrict the urethra and to flatten the vaginal walls.

DEEP TRANSVERSE PERINEAL MUSCLE.—The deep transverse perineal muscle (*m. transversus perinei profundus; constrictor urethrae*, or *compressor urethrae* when considered together with the preceding muscle) lies in the same plane as the urethral sphincter, with the posterior border of which it is so closely blended as to be scarcely separable from it. On each side the muscle takes origin through a short tendon from the ramus of the ischium; the two expand somewhat as they run medialward, where, in the middle line they become tendinous and interweave. Some of the anterior fibers, like those of the sphincter, insert into the vaginal wall; others passing backward no longer remain confined to the compartment, but end in the perineal body. Through its action as a tensor, the muscle assists in supporting the pelvic floor.

SUPERIOR FASCIA OF THE UROGENITAL DIAPHRAGM.—The upper lamina of the two-layered deep fascia in the urogenital triangle is termed the superior fascia of the urogenital diaphragm (*fascia diaphragmatis urogenitalis superior;* posterior, superior, or deep layer of the triangular ligament). It forms at once the roof of the deep perineal compartment (left half, Fig. 84), and the floor of the anterior recess or extension of the ischiorectal fossa on either side of the midline. Although the superior and the inferior diaphragmatic fascial layers are intimately connected with each other behind and in front, the deep layer is strictly a medially directed lamella from the parietal portion of the pelvic fascia, since it is derived from the fascial covering of the obturator internus muscle along the line of the latter's attachment to the periosteum of the ischiopubic rami (right half, Fig. 95).

Anteriorly the superior fascia of the urogenital diaphragm, conjoined with the inferior layer, forms the transverse ligament of the pelvis (Figs. 84 and 85); at the sides, as stated, it meets the obturator fascia; behind it is again continuous with the inferior fascia around the deep transverse perineal muscle, and, through the medium of the inferior fascia, with the deep (Colles's) layer of the superficial fascia. Medially and above it joins the fascial covering on the under surface of the levator ani muscle (Fig. 83).

Anterior Recess of the Ischiorectal Fossa.—In the urogenital half of the perineum, above the superior fascia of the urogenital diaphragm on either side, the fat-filled ischiorectal fossa extends forward for a distance of about 5.5 cm. The space (opened in Fig. 85) in shape resembles a triangular prism (insets, Fig. 83), the base of which adjoins the larger area in the anal part of the perineum. The lateral boundary of the space is formed by the parietal fascia covering the obturator internus muscle (Fig. 85); the superior boundary is the inferior fascia of the pelvic diaphragm which invests the under surface of the levator ani muscle; the inferior boundary is the fascia, likewise diaphragmatic, on the upper surface of the urethral sphincter.

It should now be clear that, whereas the fatty superficial fascia of the ischiorectal fossa in the anal region is the only layer between the skin below and the fascia of the pelvic floor above, in the urogenital triangle a series of important additional strata (turned outward in Fig. 85, viewed in coronal section in Fig. 95) intervene between the two; these layers are: the deep membranous layer of the superficial fascia, the erectile tissue and the muscles of the superficial compartment, the inferior fascia of the urogenital diaphragm, the musculature in the deep compartment, the superior fascia of the urogenital diaphragm, and the fatty tissue in the anterior recess of the ischiorectal fossa. Were these strata not present the succession of layers in the two subdivisions of the perineum (anal and urogenital) would be similar and, moreover, comparable to that obtaining over the body generally, namely, the integument, the fatty pannicle, and the deep fascial investment of the muscles. In the anal triangle the diaphragmatic fascial layer on the under surface of the levator ani muscle is the third reached as the dissector works inward; in the urogenital triangle, the same layer is the ninth stratum encountered.

Pelvic Diaphragm.—The pelvic diaphragm (*diaphragma pelvis*) forms the conical or funnel-shaped musculo-tendinous partition between the perineum below and the pelvic cavity above. It is made up of two pairs of muscles, the levatores ani and the coccygei, invested on the perineal and the pelvic surfaces by a layer of fascia (Figs. 84 and 85). From the pelvic wall on each side the muscles pass downward toward the median line, there to meet each other and fuse, or to surround the terminal portions of the anus, the vagina and the urethra. The concave surface of the diaphragm is directed toward the pelvic cavity.

Inferior and Superior Fasciae of the Pelvic Diaphragm.—The inferior fascial layer (*fascia diaphragmatis pelvis inferior;* anal layer of the diaphragmatic fascia; anal fascia or ischiorectal fascia) covers the under surface of the pelvic diaphragm; it faces downward and lateralward. Superiorly it springs from the parietal layer of fascia covering the obturator internus muscle, along the line of origin of the levator ani muscle; medially it meets the fasciae of the anal sphincters; anteriorly it blends with the superior fascia

of the urogenital diaphragm, posteriorly, with the fascia on the inner or deep surface of the gluteus maximus muscle.

The superior fascial layer (*fascia diaphragmatis pelvis superior;* visceral layer of the diaphragmatic fascia) covers the upper surface of the pelvic diaphragm (hereinafter, pages 250 and 251) following the line of origin of the levator ani muscle and extending along the lateral pelvic wall in a tendinous arch from the pubic symphysis to the iliac spine, and therefrom downward and medialward to cover the muscles of the diaphragm and to invest closely the viscera in the lesser pelvis. The viscera, with their thickened fibrous tunics, are in turn lodged in an areolar tissue basis (right half, Fig. 86). This packing, which intervenes between the fascia and the peritoneum of the pelvis, is likewise the bed through which course the visceral branches of the blood vessels, nervous plexuses, and lymphatic channels. It ends superiorly at the peritoneum, to the deep surface of which it is attached.

Turning now from the perineal to the pelvic approach, a more detailed consideration of the structures in the pelvis will be undertaken; the strata will be described in the order in which they are encountered by the dissector or the operator, beginning with the peritoneum and ending with the musculature of the pelvic diaphragm.

PELVIC CAVITY

Peritoneum

The peritoneal cavity (*cavum peritonaei*) is the space revealed by incising and reflecting the abdominal wall. It is lined by a serous membrane (*tunica serosa*), the peritoneum, which, upon its internal free surface, is smooth and glistening, and, upon its external surface, is roughened for attachment to the subserous or extraperitoneal connective tissue (*tela subserosa*), intervening between the peritoneum itself and the fascial lining of the abdominal parietes.

Whereas, in the abdominal cavity proper, the parietal peritoneum is reflected outward upon portions of the alimentary tract in the form of a complicated series of supporting folds or mesenteries, in the pelvic division of the cavity it is for the most part merely carried over the upper surfaces of pelvic organs, adapting itself to the inequalities produced by them (Figs. 87 and 88). By their presence it is prevented from descending to the level of the pelvic diaphragm; it passes into the lesser pelvis from the anterior abdominal wall downward to the upper surface of the urinary bladder; therefrom it is carried over the uterus, and, extending lateralward on the uterine appendages, reaches the lateral wall of the pelvis as the broad ligaments; from the posterior surface of the uterus and its ligaments the peritoneal layer is next carried upward upon the front of the rectum, where it attains the posterior abdominal wall.

In passing downward into the lesser pelvis to clothe the upper surface of the bladder, the peritoneum is elevated over the intra-abdominal cordlike remnant of the allantois (urachus or middle umbilical ligament) to form the middle umbilical fold (*plica umbilicalis media*), to each side of which is a lateral umbilical fold (*plica umbilicalis lateralis*) over the obliterated hypogastric artery; and as the peritoneum descends from the lateral pelvic wall to the bladder, on each side of the organ a shallow depression is formed, termed "the paravesical fossa." Traced over the posterior border of the bladder, the peritoneum ascends to cover the vesical surface of the body of the uterus

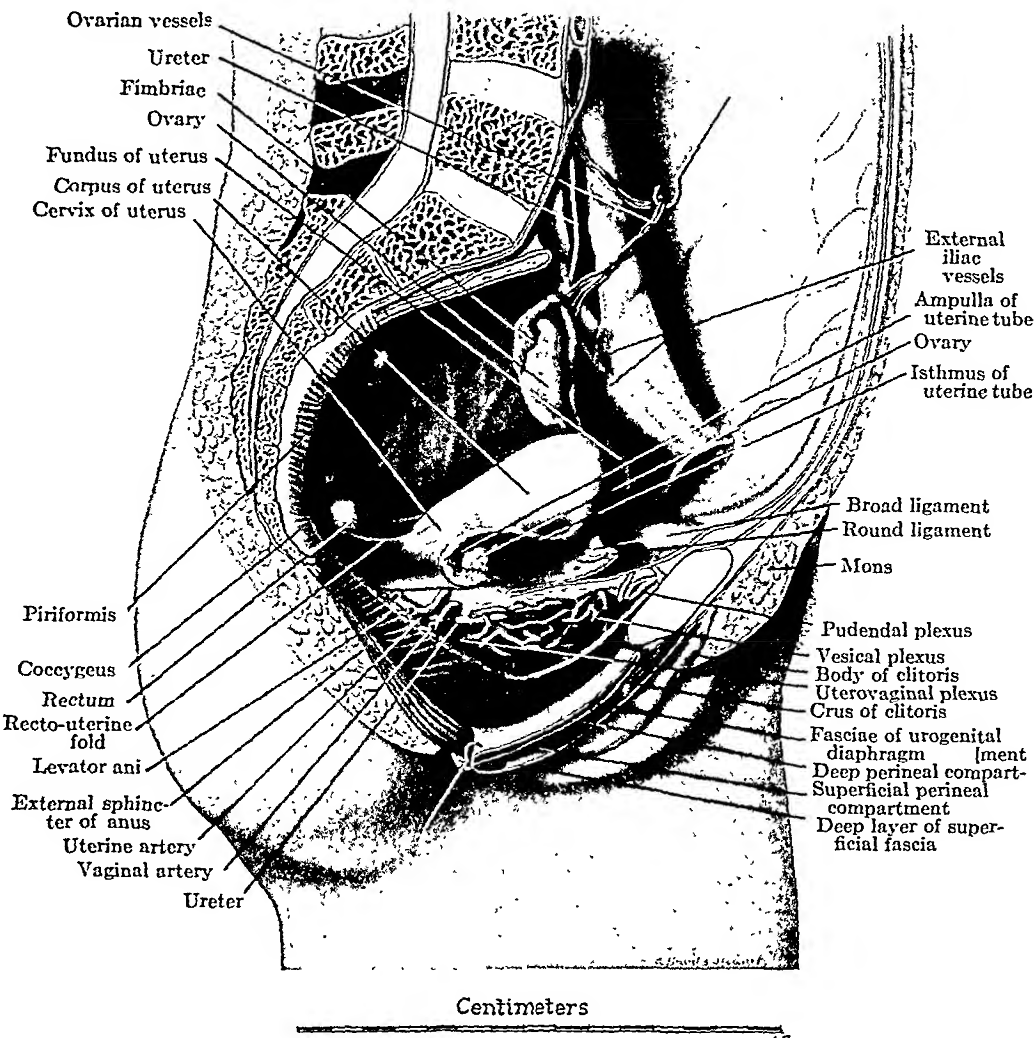


Fig. 88.—Paramedian section of the female pelvis. The pelvic venous plexuses are shown in relation to the organs. The peritoneum has been cut away to show the ureter and the ovarian vessels. The right ovary is shown in the position which it holds in the living body.

(Figs. 87 and 94); it rests upon the funnel-shaped pelvic diaphragm. By these structures the organ is molded to the form of a three-sided pyramid. The larger end, the base or fundus of the bladder (*fundus vesicae*), rests against the anterior wall of the vagina; the smaller end, the apex or vertex (*vertex vesicae*), reaches forward to the pubic symphysis, and is continuous with the middle umbilical ligament (*lig. umbilicale laterale*) which extends upward on the anterior abdominal wall to the umbilicus. The body of the organ (*corpus vesicae*) is the portion between the fundus and the vertex. The bladder is triangular in either sagittal (Fig. 87) or coronal section (Fig. 95). Hence, on its under aspect, which is directed downward toward the pelvic floor, three triangular areas are distinguishable: two inferolateral areas or surfaces, and a postero-inferior surface which corresponds to the base or fundus. Each inferolateral surface looks downward and outward, and is separated from the superior fascia of the pelvic diaphragm by the veins of the pudendal plexus and the fatty subserous tissue in which they are situated; they extend backward to meet the postero-inferior surface, and approximately at the point of meeting of the three in the middle line below, the internal urethral orifice is situated. The postero-inferior surface looks downward and backward, and rests against the uterus and the upper part of the vagina. At the lateral extremities of the posterior surface the ureters pierce the wall of the bladder. The upper aspect, or superior surface, of the bladder looks upward and backward; it alone possesses a full peritoneal investment; the serous covering is carried downward for a short distance upon the posterior surface of the organ; thence it is reflected upward upon the anterior surface of the overarching uterus to form the shallow vesico-uterine excavation.

The bladder, as well as the other pelvic viscera, is lodged in the extraperitoneal or subserous areolar tissue and is closely enveloped by a stronger covering, the vesical layer of the endopelvic fascia, which is reflected upon the organ from the fascia of the pelvic diaphragm.

The female urethra (*urethra muliebris*) begins at the internal urethral orifice (*orificium urethrae internum*) upon the most dependent portion of the bladder, and ends at the external urethral orifice (*orificium urethrae externum*), as a small vertical slit, on the roof of the vestibule (page 204). It has a length of 4 cm., and represents, approximately, the prostatic and cavernous portions of the urethra in the male. The region of the bladder immediately surrounding the origin of the urethra is sometimes termed the neck; from this point the canal follows a slightly curved course downward and forward (Fig. 87); in leaving the pelvis, the urethra passes through the anterior cleft in the levator ani muscle (Fig. 85); next it pierces the superior fascia of the urogenital diaphragm (Fig. 84), and in this part of its course it traverses the deep perineal compartment, surrounded by the sphincter muscle. Its external opening is placed between the labia minora immediately in front of the vaginal orifice, and about 2 cm. behind and below the tip of the clitoris. The opening to the exterior is slitlike, and is bounded by elevated margins.

The ureters, throughout their course, lie beneath the peritoneum (Fig. 87), embedded in the subserous tissue. The pelvic portion of each ureter (*ureter: pars pelvina*) is about 13 cm. in length, and extends from the brim of the pelvis minor to the posterior wall of the bladder; in its downward course (Figs. 89 and 94) it is directed at first posteriorly, then anteriorly, describing a curve that is concave forward and inward. It lies on the lateral pelvic wall,

along the anterior border of the greater sciatic notch, where it forms the posterior boundary of the ovarian fossa (page 235), it then crosses the medial aspect of the hypogastric and umbilical (obliterated hypogastric) arteries, and the obturator vessels and nerves. At the level of the ischial spine the ureter turns inward upon the pelvic floor, surrounded by the venous tributaries of the vesical plexus, which separate it from the superior fascia of the pelvic diaphragm; it next traverses the lowest portion of the broad ligament, surrounded by the uterine venous plexus, and accompanied for a distance of 2.5 cm. by the uterine artery. The ureter passes the supravaginal part of the cervix, about 1.5 cm. distant from its side, to reach the interval between the vagina and the bladder. Continuing the inward course, it ends by piercing the posterior vesical wall obliquely. On the surface of the bladder the right and left ureters are approximately 5 cm. apart.

Sigmoid Colon and Rectum.—The sigmoid colon (*colon sigmoideum;* pelvic colon, sigmoid flexure) is the portion of the large intestine (*intestinum crassum*) which begins at the superior aperture of the pelvis minor, where it is continuous with the iliac part of the descending colon (*colon descendens*), and ends opposite the third segment of the sacrum by passing into the rectum (*intestinum rectum*). The sigmoid colon enters the lesser pelvis by passing over the medial border of the left psoas major muscle, crosses the front of the sacrum first to the right side of the pelvis, and then passes back to the left—describing the characteristic S-shaped figure; on the posterior pelvic wall and near the middle line opposite the third sacral vertebra it turns downward to join the rectum. It is, unlike the portions of the gut between which it intervenes, provided with a mesentery, the sigmoid mesocolon (*mesocolon sigmoideum*); the mesentery decreases in length from the center of the loop of colon toward either end, where it disappears, leaving the sigmoid colon fixed beneath the parietal peritoneum above and below. The rectum (Fig. 87) extends from the termination of the sigmoid colon, opposite the middle of the third piece of the sacrum, to a point 5 cm. below the tip of the coccyx, where it becomes the anal canal (*pars analis recti*); its length is about 15 cm. It is curved with the concavity forward, being adapted in shape to the anterior surfaces of the sacrum and coccyx; in addition to the sagittal curve, it likewise exhibits several lateral bends; at each such bend, usually two on the left and one on the right side, the wall of the tube is inflected into the cavity as a crescentic shelflike fold; these internal rectal folds (*plicae transversalis recti;* rectal valves, valves of Houston, valves of Kohlrausch) correspond to the creases, seen externally, which mark off the lateral curves. Beyond the coccyx the rectum is supported by the pelvic diaphragm, which it pierces in becoming continuous with the anal canal (*pars analis recti*); in so doing, it passes through the levatores ani muscles (Fig. 85). Only the upper two thirds of the rectum has a partial peritoneal investment; the lower third is enveloped by loose connective tissue.

The anal canal begins at the level of the levatores ani muscles where, for a short distance, it is situated in the thickness of the pelvic floor; here it departs from the vagina (Fig. 87), is directed backward, and makes a sharp angle with the rectum which brings it to the surface at the anal orifice (*anus*) about 3 cm. behind the vaginal orifice. In passing through the pelvic diaphragm, it is surrounded not only by the levatores ani muscles, but also

vaginal wall into two segments: an upper supravaginal portion (*portio supravaginalis*), above the ring of attachment, and a lower free segment or vaginal portion which projects into the vault of the vagina. The cervix enters the vagina through the upper part of its anterior wall, in such a manner that the external orifice of the cervix is directed downward and backward to rest against the posterior vaginal wall; the latter ascends to a higher cervical level than does the anterior wall—even to envelop fully the inferior third of the cervix. The free projecting surface of the vaginal (or infravaginal) portion of the cervix is a convex prominence, transversely elliptical in form, with two rounded prominent lips enclosing a transverse opening. The anterior of the two lips (*labium anterius*) is lower, more rounded, and less projecting; the posterior lip (*labium posterius*) is thinner and longer. The aperture which they surround is the external mouth of the womb (*orificium externum uteri*); in the virgin it is a relatively small oval opening, but, after childbirth, it becomes a wider slit with an irregularly nodular margin.

The cervix is covered on its posterior surface by peritoneum; but on the anterior and lateral surfaces it is in contact with extraperitoneal connective tissue, and related respectively to the bladder and the broad ligaments.

In the virgin, the uterus lies with its long axis parallel to that of the superior aperture of the pelvis minor, and almost at right angles with the long axis of the vagina, which corresponds to that of the inferior aperture of the pelvis. As has been mentioned, the fundus of the uterus is directed forward, and the surface which might be termed anterior is actually brought downward to rest upon the bladder—a position which is described as one of *anteversion;* moreover, the organ is bent forward upon itself, being concave on its vesical or anterior surface, into a position of *anteflexion.*

Anteflexion and anteversion may be diminished or increased by distention of the bladder or the rectum; as the bladder fills, the organ is displaced backward and upward, and the degree of anteversion is decreased; on the other hand, in distention of the rectum, the uterus is carried forward, and anteflexion may become sharper. The uterus is said rarely to occupy an exactly median position; it is usually not only bent a little to one side or the other, but also slightly rotated upon its own long axis.

The cavity of the uterus (*cavum uteri*) is small in comparison with the size of the organ, because of the thickness of its walls. In sagittal section (Fig. 87) the cavity of the corpus is merely an elongated narrow cleft, between bulky muscular walls that are almost in contact with each other; in transverse section its outline is a flattened ellipse; when viewed in frontal section (Figs. 96 and 98), it has the form of a triangle, all sides of which are convex inward. The base of the triangle is directed upward, and its two upper corners go over as small funnel-shaped orifices into the uterine tubes; the apex of the triangle is directed downward, where, at a constricted aperture, the internal orifice (*orificium internum uteri;* internal os), corresponding to the isthmus externally, it becomes continuous with the cervical canal. The canal of the cervix (*canalis cervicis uteri*) is spindle shaped and compressed somewhat anteroposteriorly so as to have an oval outline in transverse section. The canal opens below into the vagina at the external orifice (*orificium externum uteri;* external os), at the tip of the vaginal portion of the cervix. Its mucous membrane, on the anterior and the posterior walls, is raised into a series of palmate folds (*plicae palmatae*); the series consists, on each wall, of a longi-

In the upper two thirds of the young cervix the epithelium is, like that of the corpus, simple columnar and occasionally ciliated; in the lower third toward the external orifice of the uterus it loses its cilia and changes gradually to stratified and squamous epithelium, resting upon connective tissue papillae; it thus comes to resemble the lining of the vagina of which it is a continuation. In older persons, and especially in multiparae, the squamous epithelium encroaches upon the columnar, to extend in exceptional cases throughout the length of the cervical canal.

The tubular cervical glands extend downward from the surface into the stroma, and are lined by columnar epithelium—even where the outer epithelium is stratified; they are wider, shorter, and more richly branched than the glands of the corpus; they are true mucus-secreting glands, their tenacious discharge effectually closing the cervical canal during pregnancy. When the orifices of the cervical glands become occluded they produce retention cysts which are visible to the naked eye; in the fresh, they appear as clear yellow vesicles, about the size of small peas, shining through the mucous membrane; they have long been called "nabothian follicles" or "ovules of Naboth" after the German anatomist and physician who first described them (*De Sterilitate; Lipsiae*, 1707).

The connective tissue underlying the mucosa in the cervix is more fibrous and less cellular than that of the corpus.

Ligaments of Uterus.—The attachments of the uterus consist of two pairs of ligaments, which because of their shape are termed the broad and the round.

Each broad ligament (*lig. latum uteri*) is a double layer of peritoneum directed from the lateral margin of the uterus to the lateral wall of the pelvis (Figs. 88 and 96). The plane of the medial end is dependent upon the position of the uterus; when the latter is normally placed (Fig. 94) the anterior surface looks downward and forward, and the posterior surface upward and backward; at the attachment to the pelvic wall the plane is more nearly vertical. When retracted (Fig. 96) their form is observed to be that of quadrangular winglike folds which jointly form a septum across the pelvis, dividing the cavity into an anterior portion containing the bladder, and a posterior housing the rectum. The upper free border of each ligament is then approximately horizontal. It is the longest of the four borders, and for its inner four fifths is occupied by the uterine tube; a shorter lateral part extends beyond the tube, from the fimbriated end to the wall, as the suspensory ligament of the ovary (Fig. 98, A). The other three borders—medial, lateral, and inferior—are fixed. The medial border is attached to the side of the uterus, where the layers diverge to surround the organ as its serous covering; the short lateral border is attached to the lateral wall of the pelvis just in front of the hypogastric artery; the inferior border, or base, of the ligament is rounded; sloping downward and inward it follows the plane of the pelvic floor to which it is fastened, and ends medially on the upper portion of the vagina. At their lines of attachment to the pelvic wall and floor, the two layers of the broad ligament pass in opposite directions, becoming continuous with the general peritoneal lining of the pelvic cavity. Along the inferior attachment, the divergence of the layers leaves a nonperitoneal interval through which the ureter passes diagonally forward and medialward, and the vessels and nerves reach the sides of the vagina and the uterus.

The two layers of peritoneum which form the broad ligament enclose the extraperitoneal connective tissue, which, as it reaches the uterus, is termed the parametrium; between the two layers are also contained the following structures: the uterine tube; the paroophoron and the epoophoron; fibers from the superficial layer of the uterine musculature; visceral branches of

nervous and vascular systems. Two secondary folds originate from the broad ligament, one from each surface: from the posterior extends a fold, the *mesovarium*, containing the ovary and the ovarian ligament; from the anterior passes a less prominent fold which contains the round ligament of the uterus. The part of the broad ligament below the origin of the mesovarium is called the mesometrium; the narrower portion above, between the ovary and the uterine tube, is the mesosalpinx.

The round ligaments are not duplications of the peritoneal lining of the pelvis but are true ligamentous bands. They represent the lower part of the gubernacula, which in embryos of both sexes descend through the abdominal parietes to the inner surface of the labioscrotal swellings. They are enclosed between the serous layers of the broad ligaments, and attached medially to the upper angles of the uterus in front of and below the uterine tubes (Fig. 88). Each round ligament (*lig. teres uteri*) is composed principally of smooth muscle fibers prolonged from the uterus, together with a certain amount of connective tissue, and some small vessels and nerves. Occasionally in the adult the ligament is accompanied by a persistent tubular prolongation of the abdominal peritoneum, the canal of Nuck (*processus vaginalis peritonaei*), which in exceptional cases may extend with the ligament into the labium.

The ligament first runs in a rather horizontal plane (Fig. 94), extending outward and forward from its attachment to the anterolateral portion of the uterus to the side wall of the lesser pelvis; in this first part of its course the cord lies between the layers of the broad ligament, the anterior one of which it elevates into a low fold; it then passes in a forward and slightly upward direction (Fig. 89), under the peritoneum, crossing the obliterated hypogastric artery, the external iliac vessels, and the psoas major muscle; having thus ascended the lateral wall of the lesser pelvis, it crosses the pelvic brim, turns lateralward to attain the abdominal inguinal ring through which it leaves the abdomen to traverse the inguinal canal. In passage through the canal, the ligament is accompanied by short sparse bundles of muscle fibers contributed by the internal oblique and transversus abdominis muscles which together represent a poorly developed cremasteric layer. Upon emerging through the subcutaneous inguinal ring the ligament terminates by breaking up into a number of fine fibrous strands, most of which become lost in the superficial fascial layer of the labium majus; a smaller number become attached to the aponeurotic margins of the ring, and others expand upon forepart of the pubic symphysis.

Vagina.—The vagina is the flattened but distensible muscular and membranous canal which extends from the cervix of the uterus above to the external genitalia below (Fig. 87). The course of the vagina is downward and forward in a direction generally parallel with the plane of the superior aperture of the pelvis minor. The long axis of the vagina forms with that of the anteverted uterus an angle of about 90 degrees open toward the pubic symphysis; consequently the uterus has the appearance of becoming continuous with the vagina by piercing the latter's anterior wall. The portion of the obliquely placed cervix uteri which thus lies within the upper end of the vaginal canal ends in two freely projecting labia, a short anterior and a longer posterior one; as the vagina expands to embrace the labia, a narrow annular groove, the fornix (*fornix vaginae*), is formed between the vaginal

wall and cervical lips, which for convenience is often considered as consisting of an anterior, a posterior, and two lateral fornices. Since the vagina, in becoming united to the cervix, rises higher upon the posterior than upon the anterior lip, the posterior fornix is the deeper of the two, and the corresponding vaginal wall is longer (8 cm. as compared with 6.5 cm.). In the middle portion of its course, the anterior and posterior walls are in contact, and the contained cavity is reduced to a transverse slit. In the lower portion the cavity is invaded by prominent median elevations or columns (*columnae rugarum*) from the anterior wall (*paries anterior*) on the posterior wall (*paries posterior*) in such a manner that the lumen, as seen in transverse section, is modelled to the form of a letter H with long crossbar and shorter lateral limbs convex medialward (Fig. 98, E). The lower portion of the anterior column is especially pronounced, owing to the bulging produced by the adjacent urethra; here the column is raised to form the urethral carina (*carina urethralis*)—a crestlike elevation situated just dorsal to the external urethral orifice. From each side of the longitudinal columnae, in nulliparae, numerous transverse ridges (*rugae vaginales*) extend obliquely outward, lending a corrugated appearance to the surface of the lining membrane; the transverse rugae are particularly conspicuous on the anterior wall; in general they fade away as the lateral walls are approached. The breadth of the vaginal canal decreases from above downward; it opens below to the exterior through the vaginal orifice which communicates directly in the vestibular space enclosed by the labia minora (page 204 and Fig. 80). The size and shape of the orifice are dependent upon the condition of the hymen.

The vagina is intimately related anteriorly to the urinary bladder and the urethra (Fig. 87); the fundus of the bladder rests against the upper part of the vagina, while below the level of the bladder the urethra indents the anterior vaginal wall to produce the keellike urethral carina. The fibrous tissue intervening between the vagina and the bladder is loosely areolar; that which connects the vagina to the urethra is more dense. They are frequently termed the vesicovaginal, and the urethravaginal, septum respectively, but are continuous with each other, and blend with the coats of the organs, the surrounding extraperitoneal tissue, and the pelvic fascia. Posteriorly, the upper segment of the vaginal wall (behind the posterior fornix) is related to the recto-uterine excavation of the peritoneum; in the middle two fourths the vagina lies in close apposition with rectum, the contents of the latter viscus being easily palpable through the vaginal wall. Here the two are connected by a fibrous extension of the pelvic fascia, termed the rectovaginal septum. In the lower fourth the vagina and the rectum diverge, and, at the beginning of the anal canal, are separated by an interval occupied by the perineal body (page 207). Laterally, and above the level of the pelvic floor, the vagina is related to the vaginal branches of the uterine artery, the vesicovaginal plexus of veins and the terminal part of the ureter which passes forward and inward near the lateral fornix to reach the base of the bladder; all of these structures are embedded in the loose extraperitoneal connective tissue. At the junction of its lower and middle thirds the vagina is enclosed by the levatores ani muscles and the two investing layers of diaphragmatic pelvic fascia, through the anterior cleft in which it leaves the pelvic cavity (Fig. 85); the vagina next traverses the urogenital diaphragm (Fig. 84) from whose musculature and fasciae it obtains additional support;

it finally passes through the superficial perineal compartment (Fig. 82), where on either side it is related to the bulb of the vestibule and the bulbocavernosus (*sphincter vaginae*) muscle (Fig. 81), and ends by opening upon the roof of the vestibule (Fig. 80).

STRUCTURE OF VAGINA.—The wall of the vagina is composed of three principal coats, an outer fibrous, a middle muscular, and an inner mucous coat. The outer adventitial or fibrous layer forms, with the pelvic fasciae and extraperitoneal tissue, a dense sheath which clothes the vagina and connects it with surrounding structures—the bladder, urethra, rectum and pelvic diaphragm; it also serves as the substrate through which course the vaginal nerves and vessels, including an abundant venous plexus. The fibrosa is made up of closely felted bundles of connective tissue containing many elastic fibers. The muscular coat consists of somewhat irregularly arranged groups of smooth muscle fibers, among which a considerable amount of connective tissue is distributed; this arrangement renders the transition to the outer fibrous coat a very gradual one, in which sharp delimitation is wanting; some scattered bundles are intermingled with those of the levator ani muscle, and through the latter as an intermediary may reach the perineal body; others at a lower level mingle with striated musculature in the perineal compartments. The fibers in the muscularis are arranged chiefly in a longitudinal direction, but two separate layers are said to be distinguishable; an inner circular and an outer longitudinal. The lining mucous membrane (Fig. 98, J) consists of a thick layer of stratified squamous epithelium which rests upon numerous vascular papillae of fibro-elastic tunica propria. The epithelium is continuous above with that of the vaginal portion of the cervix, and below with the epidermis which it rather closely resembles in structure; sporadic "vaginal" glands found in it are regarded as anomalous; its surface is rugose. In the tunica propria solitary lymph nodules (*noduli lymphatici vaginales*) are of occasional occurrence. The deeper portion of the areolar tissue layer is permeated by a plexiform arrangement of vascular channels, and contains scattered bundles of smooth muscle cells; hence it is by some described as a *tela submucosa*, by others as erectile tissue comparable to that which is found in the bulbs of the vestibule.

Uterine Tubes.—The uterine tubes (*tubae uterinae*, fallopian tubes) are the paired muscular canals about 12 cm. in length which extend from the uterus to the ovaries; they are covered by peritoneum and lined with mucous membrane. They may be considered to represent the excretory ducts of the ovaries, since they convey the discharged ova to the cavity of the uterus; they differ, however, from all other ducts in the human body, in that the relationship of gland to duct is one of apposition merely, and not of continuity. The uterine tubes or oviducts, except for a short intramural course, are enclosed in the free margin of the broad ligaments; they occupy the upper division of the ligament which is known as the mesosalpinx (Fig. 96).

Traced from its proximal end (Figs. 88 and 94) each tube emerges from the wall of the uterus at the junction of the corpus and fundus uteri; its course is at first horizontally outward and backward along the uterine or lower extremity (pole) of the ovary; it next ascends the pelvic wall, often in a tortuous fashion along the mesovarial border of the ovary to the tubal or upper extremity, over which it arches backward; the tube finally descends upon the free border of the ovary, where its fimbriated end lies in relation with the medial surface of the ovary.

The uterine tube presents four chief subdivisions (Figs. 96 and 98, A): A short uterine portion; a slender isthmus, corresponding to the inner third of the tube; an ampulla, or dilated outer two thirds; a distally placed fringed and funnel-shaped infundibulum. The uterine part (*pars uterina*) begins at the upper angle of the uterine cavity, with which it communicates by a minute orifice or ostium (*ostium uterinum tubae*); the tube then traverses the muscular

wall, appearing externally at the cornu, just above the uterine attachments of the round and the ovarian ligaments. The isthmus (*isthmus tubae uterinae*) is the straight cordlike portion immediately adjoining the uterus; it is thick-walled and relatively narrow. The lumen of the isthmus gradually increases in diameter as it passes outward to join the ampulla (*ampulla tubae uterinae*), which is thin-walled and dilatable. The ampulla is the widest and longest subdivision of the tube, and is usually somewhat convoluted. This flexuous portion leads into the trumpet-shape expansion of the ovarian end of the tube, termed the infundibulum (*infundibulum tubae uterinae*), the inner surface of which is thrown into folds continuous with those of the ampulla. The folds are prolonged to the end of the tube, where they project in the form of long irregular processes or fimbriae (*fimbriae tubae*) which give to the free margin a fringed or ragged appearance. One fold, longer than the others, stretches toward the ovary and often attains the tubal pole; this ovarian fimbria (*fimbria ovarica*) is attached throughout its length to the mesosalpinx of the broad ligament. The uterine tube communicates directly with the peritoneal cavity by a small aperture, the abdominal ostium (*ostium abdominale tubae uterinae*), situated in the depths of the infundibulum.

Structure of Uterine Tubes.—The wall of the uterine tube grows progressively thinner from the isthmus to the infundibulum, while the lumen becomes broader. The wall is made up of three coats, an external, serous layer, an intermediate muscular, and an internal mucous layer. The serous coat is derived from the peritoneal laminae of the broad ligament in the upper margin of which the tube is situated; the serous layer invests the tube throughout its length except over the uterine portion and along the line of attachment of the mesosalpinx. The mesothelial cells of the serosa rest upon a layer of subserous connective tissue through which ramify the tubal branches of the vessels and nerves contained in the mesosalpinx. The subserous tissue rests directly upon the muscular layer and is continuous with the abundant intermuscular connective tissue which separates the coarse muscular bundles; the latter are, in general, arranged in two strata, a more superficial one of longitudinally arranged fibers, and a deep thicker layer in which the fibers are disposed circularly. The transition to the mucous membrane is gradual, and consequently some authors suggest that a portion of the muscular layer is properly mucosal, stating that it represents a thickened *lamina muscularis mucosae*. Usually, however, the mucosa is regarded as consisting of two rather than three portions, a very cellular *tunica propria* and a lining layer of simple columnar ciliated epithelium, which at the abdominal end of the tube is directly continuous with the mesothelium of the peritoneum. The mucous membrane is thrown into delicate but permanent longitudinal folds (*plicae tubariae*) which assume a more complicated pattern as the fimbriated end is approached; the plications begin in the pars uterina usually as four low simple folds (Fig. 98, G) which enclose a small lumen cruciate in cross section; in the isthmus they become larger and the primary folds possess a few thinner secondary rugae; in the ampulla the primary folds are tall and are beset with very numerous accessory ones which, extending in every direction, almost obliterate the otherwise capacious lumen with their complex arborescent branchings (Fig. 98, H). The deep furrows between the folds may simulate glandular structures, but true glands are absent.

Ovaries.—The genital glands of the female (*ovaria*) are homologous with the testes in the male. They are solid nodular bodies, with the proportions of a large unshelled almond, situated on either side of the uterus, behind and below the uterine tubes (Figs. 88 and 94). They are attached to the back of the broad ligament and to the lateral wall of the lesser pelvis by peritoneal folds (Fig. 98, A). The ovaries contain numerous ova which are discharged during ovulation by the periodic rupture of the follicles; in addition to being cytogenic glands, the ovaries produce hormones regulatory of the devel-

opment and activity of the female reproductive organs. The ovaries show considerable individual variation in size, and the right is commonly somewhat larger than the left. The average dimensions are 3.6 cm. in length, 1.8 cm. in breadth, and 1.2 cm. in thickness. Each ovary possesses two extremities and two surfaces—the latter separated by borders along one of which the hilum is situated.

When the body is in the erect posture, the normally placed gland rests against the inner aspect of the pelvis with its long axis (connecting the two extremities) in the vertical plane,[1] and its greater diameter (connecting the two margins) in parasagittal plane. The tubal extremity (*extremitas tubaria*), or upper pole, of the organ is rounded, directed superiorly, and embraced by the uterine tube; it is attached to the peritoneum of the pelvic wall above by the suspensory ligament, and usually also to the ovarian fimbria of the uterine tube. It reaches upward almost to the level of the external iliac vein and the pelvic brim, to be overhung by the medial edge of the psoas major muscle. The uterine extremity (*extremitas uterina*), or lower pole, is narrow, pointed, and directed inferiorly; it is fastened to the adjacent lateral margin of the uterus by the ligament of the ovary. The lower pole reaches downward almost to the level of the pelvic floor, to a point just above the upper border of the piriformis muscle and the ischiadic (sciatic) nerve. The medial surface (*facies medialis*) is directed inward, but, since it is to a great extent covered by the uterine tube, only a relatively small part of it is exposed free to the pelvic cavity and to the contained portions of the intestines. The lateral surface (*facies lateralis*) faces outward and is in direct contact with the parietal peritoneum of the pelvis, where this layer is depressed to form a shallow fossa (*fossa ovarii*) of triangular outline, in the angle between the diverging external iliac and hypogastric vessels. The lateral umbilical ligament (obliterated hypogastric or umbilical artery) in front, and the ureter and uterine artery behind, form, as they lie in the extraperitoneal fatty tissue, the immediate boundaries of the recess. The obturator vessels and nerve, coursing obliquely across the obturator internus muscle, intervene between the peritoneum of the fossa and the bony wall of the pelvis. Below, the boundary of the fossa is indistinct, fading insensibly into the pelvic floor. Two margins connect the surfaces. The posterior margin or border (*margo liber*) is free, thick, and rounded; it is directed backward, and slightly inward toward the ureter. The anterior margin (*margo mesovaricus*) is narrower and straighter than the posterior; it is directed forward and somewhat outward toward the obliterated umbilical artery. This border presents an oblong groove or hilum (*hilus ovarii*), and is attached by a short peritoneal fold (*mesovarium*) to the back of the broad ligament of the uterus (Fig. 98, A); between the approximated layers of the mesovarium the vessels and nerves reach the hilum.

Ligaments of Ovary.—In addition to the mesovarium, by which the ovary is attached to the posterior surface of the broad ligament, the organ possesses

[1] Dr. Arthur H. Curtis states that in living subjects (lying supine) the ovary varies greatly in position in different individuals; that it is almost invariably below the level of the fundus of the uterus, with the long axis often oblique or vertical, not always horizontal, as is characteristic of its position when studied in the dissecting room. (Figure 88, right, illustrates the position of the ovary as encountered in the living subject at operation.) Contraction of the suspensory ligament and the contained vessels, through the action of preservatives, may account for the position of the ovary observed in the dissecting room.

two other supporting structures, namely, the ovarian and the suspensory ligaments. Each ovarian ligament (*lig. ovarii proprium;* utero-ovarian ligament) is a rounded cord, consisting of connective tissue and smooth muscle which lies enclosed between the layers of the broad ligament, where it may be seen through the peritoneum as it courses along the line separating the mesosalpinx from the mesovarium. It extends from the uterine or lower extremity of the ovary to the lateral aspect of the uterus, where it is attached between the uterine tube and the round ligament of the uterus. The ligament of the ovary and the round ligament of the uterus together represent the embryonic gubernaculum of the ovary, the entire cord being subdivided into ovarian and uterine portions.

Each suspensory ligament (*lig. suspensorium ovarii;* infundibulopelvic ligament) extends from the tubal extremity of the ovary to the lateral wall of the pelvis, and is the lateral one fifth of the broad ligament which is unoccupied by the uterine tube. It is a fan-shaped band of fibrous and muscular tissue over which the peritoneum is elevated into a fold of triangular shape (Fig. 94). It passes upward from the ovary, crossing the external iliac vessels, to become lost in the fascia and peritoneum covering the psoas major muscle. The tissue in the ligament forms a bed for the ovarian vessels and nerves, as they enter the pelvis minor to gain the broad ligament and the gland.

Structure of the Ovary.—The ovary (see Chapter XII) consists of two principal portions, a narrow outer cortical layer and a deeper medullary layer. The cortex is made up of a compact stroma of connective tissue thickened in its superficial stratum to form a compact *tunica albuginea.* The cortex contains the characteristic ovarian follicles and is covered by a columnar epithelium of this layer which at the anterior margin of the organ becomes continuous with the squamous epithelium of the mesovarium. This point of transition from the dull covering of the gland to the smooth shining peritoneum, is located along the hilum of the ovary, and is visible in the gross as a white line. The central medullary layer is composed of loosely arranged bundles of connective tissue supporting numerous large blood vessels, lymphatics, and nerves; follicles are not found within it except as the larger ones may encroach from the surrounding cortex.

In childhood, the epithelial covering of the cortex is smooth, but in later life it becomes nodular over the contained follicles and pitted wherever the rupture of similar vesicles has produced a scarred depression. Each follicle is formed by a process of multiplication and rearrangement of cells, in which small, round, indifferent cells become the investing cells of the follicle forming at first a single, and later a double, layer to surround the larger cells which are the ova (Fig. 98, K). The immature follicles (*folliculi oophori primarii*) thus formed are solid, of microscopical size (0.4–0.6 mm. in diameter), and may attain an estimated 35,000 for both ovaries of young adults. A clear fluid (*liquor folliculi*) accumulates between the two layers of the maturing follicle, separating them except at one point, where, in the form of a hillock (*cumulus oophorus*), the inner cells surrounding the ovum remain attached to outer group and form for it an immediately investing layer (*zona pellucida*) (Fig. 98, L). The surrounding stroma differentiates into a two-layered envelope, the *theca folliculi;* the outer layer (*tunica externa*) is fibrous, the inner (*tunica interna*) is vascular, and is separated from the epithelium of the follicle by a delicate *membrana propria.* These large, mature vesicular follicles (*folliculi oophori vesiculosi graafi*) attain a diameter of 12 mm. and are then ready to discharge the contained ova. The mature follicles occupy not only the total thickness of the cortex, but often produce marked elevations upon the free surface of the ovary, and reach into the medulla. The gradual approach to the surface of the gland culminates in the rupture of vesicle and the discharge of the ovum and fluid contents into the peritoneal cavity, where the egg may reach the uterine tube. When rupture of the follicle occurs the walls collapse; somewhat later the cavity becomes filled with blood, into which penetrate vascular processes from the surrounding tissue; this clot is called the *corpus haemorrhagicum.* Their ingrowth is usually regarded as a simple hypertrophy of the en-

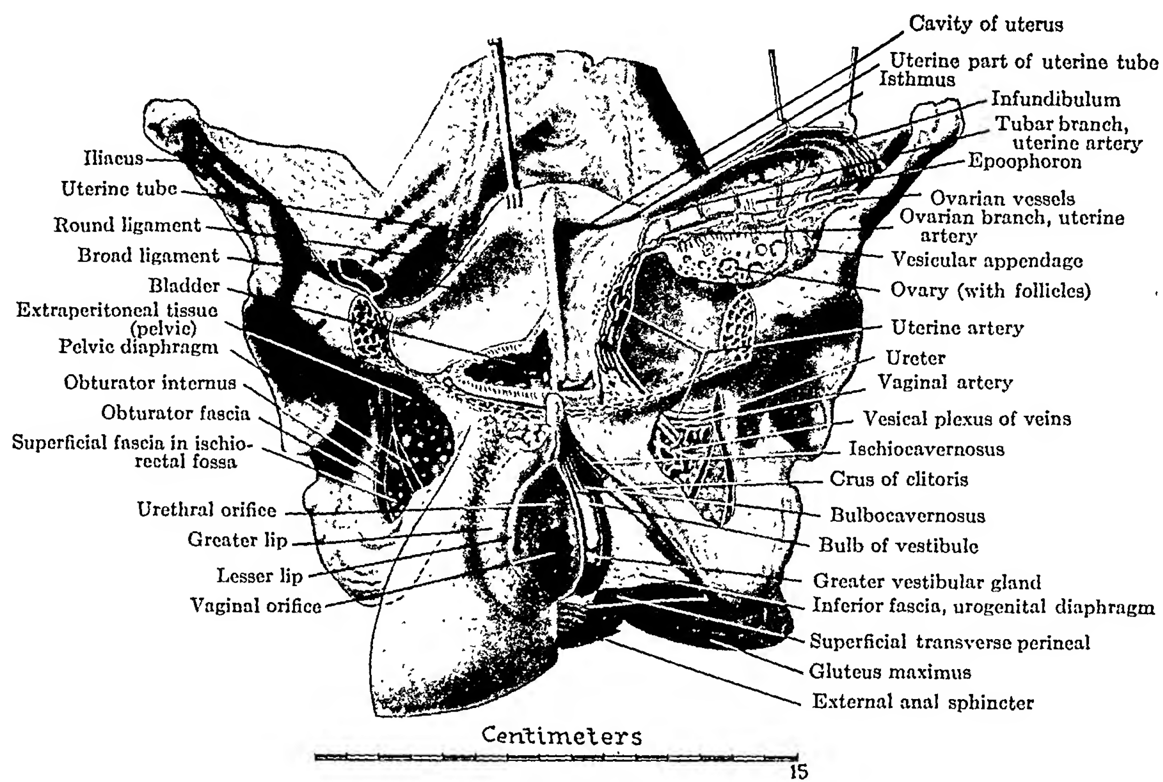


Fig. 96.—The structures of the female pelvis and perineum. The uterus has been retracted and the left broad ligament cut to show the vessels and vestigial organs; the uterine cavity is exposed and the uterine tube opened. The pubis has been cut away in front; the pelvic diaphragm is seen through the obturator foramen. The contents of the superficial perineal compartment are exposed.

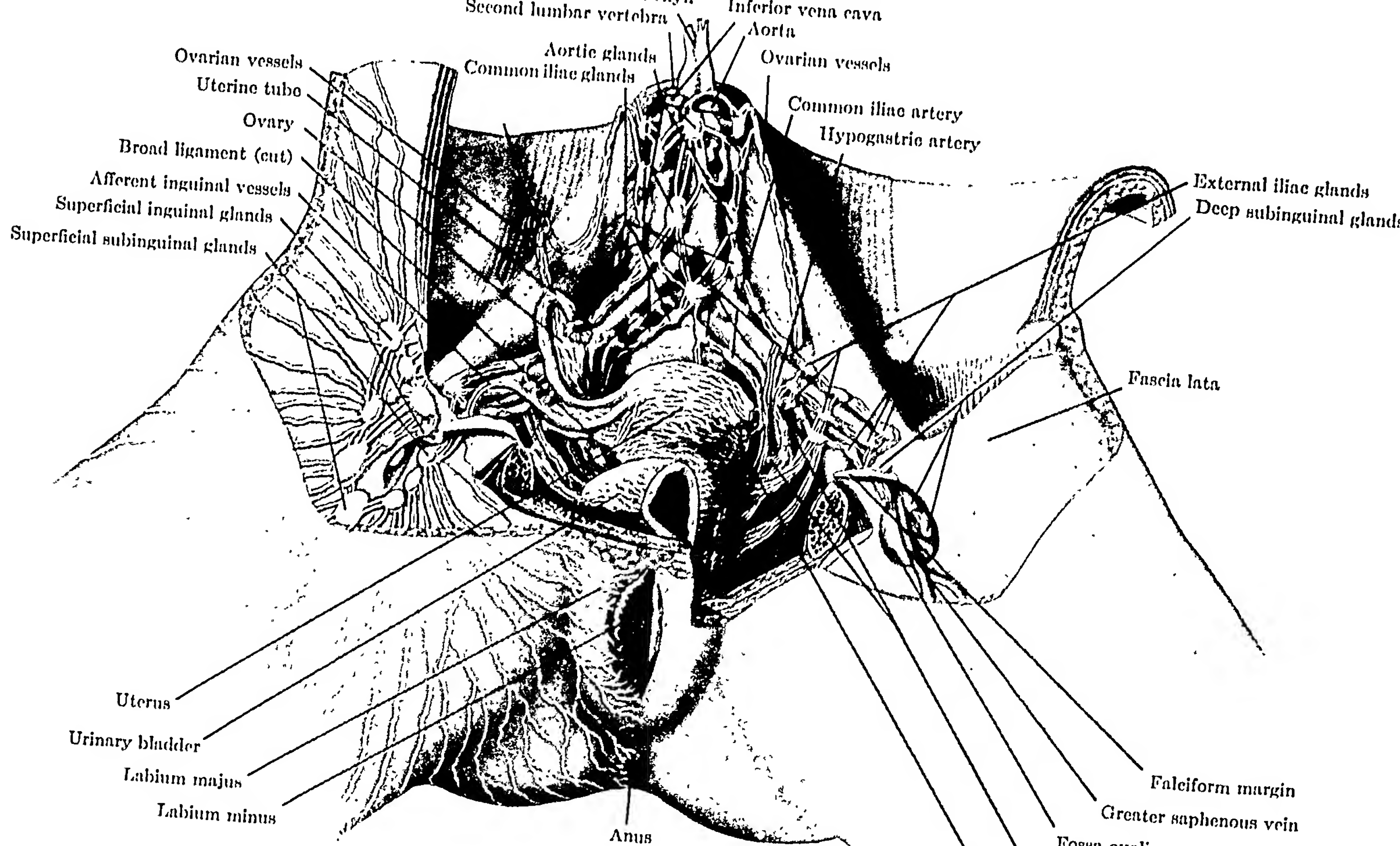


Fig. 97.—The lymphatic vessels and glands of the perineum, pelvis, and adjacent regions, in the female. (Figure from a dissection, to which lymphatics have been added after Sappey, and Poirier and Sharpy.)

from the inferior mesenteric branch of the abdominal aorta. The sigmoid arteries (*aa. sigmoideae*) usually two or three in number, arise from the convexity of the inferior mesenteric; coursing downward and to the left, they cross the left iliacus and psoas major muscles beneath the parietal peritoneum, enter the root of the sigmoid mesocolon; between its layers they give off ascending and descending branches which, by a series of arches, anastomose respectively, with the left colic artery and the superior hemorrhoidal artery. The superior hemorrhoidal artery (*a. haemorrhoidalis superior*) is the continuation of the main trunk of the inferior mesenteric. It descends into the pelvis minor between the layers of the sigmoid colon to the dorsum of the rectum. At the junction of the sigmoid colon and the rectum, opposite the third segment of the sacrum, it divides into two branches which pass from the back to the sides of the rectum; there, they break up into several finer stems, which form a series of loops around the organ, and communicate with the middle hemorrhoidal branches of the hypogastric and the inferior hemorrhoidal branches (Fig. 81) of the internal pudendal.

Ovarian Arteries.—These are homologous to the internal spermatic arteries in the male, having a similar origin relation in the abdominal part of their course; but, since they do not leave the pelvis, they are shorter than the corresponding vessels to the testes. Each artery (*a. ovarica*) arises from the front of the aorta, slightly below the point of origin of the renal arteries opposite the second lumbar vertebra. They course obliquely downward and lateralward, upon the psoas major muscle and behind the parietal peritoneum, crossing the external iliac vessels and the ureter and entering the lesser pelvis (Figs. 87 and 88). Here their route is through the suspensory ligament of the ovary (Fig. 96); they next pass between the layers of the broad ligament, below the level of uterine tube, inward toward the ovary which they attain by coursing backward in the mesovarium. The vessels divide into terminal branches which enter the hilum of the ovary, forming broad anastomoses with the ovarian rami of the uterine artery.

Internal Pudendal Artery (*Perineal Part*).—The internal pudendal artery leaves the lesser pelvis and enters the gluteal region by passing through the lower part of the greater ischiadic foramen between the piriformis and the coccygeus muscles (compare Figs. 89 and 90). After turning around the spine of the ischium it reaches the anal part of the perineum by passing through the lesser ischiadic foramen (Figs. 91 and 92); there the vessel passes along the lateral wall of the ischiorectal fossa, accompanied by its *venae comites* and the pudendal nerve. In this situation (Fig. 81) the artery lies in a fibrous canal (of Alcock) formed by the fascia covering the obturator internus muscle. In the fossa the artery of each side gives off one branch, the inferior hemorrhoidal artery (*a. haemorrhoidalis inferior*) which pierces the wall of the canal and passes medialward through the fatty tissue of the fossa to the anus and the anal canal which it supplies; by small twigs given off en route, the vessel also supplies the superficial fascia and integument of the perineum, and, in addition, the skin and musculature of the gluteal region.

On reaching the base of the urogenital diaphragm, at the line of division between the two portions of the perineum, the branches of the internal pudendal artery enter the urogenital part of the perineum by three routes: through the superficial fatty tissue just beneath the integument; through

the superficial perineal compartment; and through the deep compartment, on the way to the structures in the superficial. The first route is followed by small branches of the internal pudendal, belonging to the posterior labial group, which are distributed to the skin and fatty tissue of the labia. The second route is the one followed by the perineal artery (*a. perinei;* superficial perineal) of each side; this vessel (Fig. 81), which is one of the two terminal branches of the internal pudendal, arises within the ischiorectal fossa, and passes downward, forward, and slightly medialward to enter the superficial perineal pouch by passing either over or under the superficial transverse perineal muscles. Within the compartment its course is forward, parallel to the pubic arch, in the triangular space enclosed by the ischiocavernosus, bulbocavernosus, and transverse perineal muscles, all of which it supplies. The branch to the latter, which runs medialward to the central point of the perineum is termed the transverse perineal artery. The posterior labial arteries (*aa. labiales posteriores*) usually arise from the perineal within the compartment, and are continued forward to the labium, joining those which arose in the ischiorectal fossa by passing through the deep layer of the superficial perineal (Colles's) fascia.

The other terminal branch of the internal pudendal artery is the clitoridal, which, on leaving the perineal artery, enters the deep compartment by piercing the base of the urogenital diaphragm (Fig. 84); within the compartment it continues forward along the inferior ramus of the pubis in the substance of the urethral sphincter muscle, giving off the bulbar and the urethral arteries, and ending in the terminal branches, the deep and the dorsal anterior of the clitoris. The four branches are distributed chiefly to the erectile tissue in the superficial perineal compartment, which they reach by piercing the inferior fascia of the urogenital diaphragm. The first branch, the artery to bulb (*a. bulbi vestibuli*), is a short thick vessel which usually arises just as the clitoridal artery enters the deep compartment; occasionally it takes origin from a common stem with the dorsal artery. The artery passes medialward toward the urethra, and, before reaching the midline penetrates the inferior fascial layer to enter the cavernous tissue of the vestibular bulb (Fig. 82). The urethral artery (*a. urethralis*) takes origin anterior to the bulbar, but otherwise is similar to it in course and distribution. The deep artery of the clitoris (*a. profunda clitoridis*) in passing through the fascial floor of the deep compartment, lies just medial to the corpus cavernosum clitoridis, which it pierces obliquely. The dorsal artery of the clitoris (*a. dorsalis clitoridis*) extends forward between the fascial layers of the diaphragm to a point just behind the transverse pelvic ligament, where it passes through the inferior fascial layer and extends outward upon the dorsum of the clitoris, finally turning backward again to send branches into the glans; the vessels communicate through the pars intermedia with those from the bulbar artery.

Veins.—The tributaries of the hypogastric vein correspond with the branches of the hypogastric artery,[1] with the exception of the fetal umbilical

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(× 250). L, Section through a vesicular (graafian) follicle from the same ovary (× 35). Abbreviations: Cum. ooph., *cumulus oophorus;* epith., *epithelium;* str. gran., *stratum granulosum;* th. foll., *theca folliculi;* tun. muc., *tunica mucosa;* tun. musc., *tunica muscularis;* tun. ser., *tunica serosa;* zona pell., *zona pellucida.* Photomicrographs made for the author by Miss M. Walsh from sections in the collection of Professor L. B. Arey.

[1] In the Basle Nomenclature, *vena hypogastrica, venae dorsalis clitoridis,* et cetera.

the systemic (inferior caval) and the portal systems are brought into communication with each other.

The ovarian veins issue from the hilus of the ovary and pass between the layers of the broad ligament; here they anastomose freely, forming an extensive network which corresponds to the pampiniform plexus of the spermatic cord in the male. The plexus communicates with the uterovaginal plexus, and also gives off two ovarian veins which, corresponding to the internal spermatic veins, accompany each ovarian artery. The two veins of each side finally fuse to form a single terminal vessel which usually on the right side opens into the inferior vena cava and on the left into the left renal vein.

Lymphatic Vessels and Glands.—The afferent lymphatic vessels (*vasa afferentia*) from the integument and subcutaneous tissue of the perineum (Fig. 97), together with the superficial afferent vessels from the lower extremity, are received by a small group of lymph glands (*lymphoglandulae*) situated on either side of the upper part of the great saphenous vein (*v. saphena magna;* internal or long saphenous vein), and termed the superficial subinguinal glands (*l. subinguinales superficiales*). An adjacent group, the superficial inguinal glands,[1] arranged in a chain of ten to twenty just below the inguinal ligament, likewise receive perineal vessels, which include those from the anus and from the pudendum (vulva); into this group also pass the afferent lymphatics of the abdominal wall below the level of the umbilicus. The efferent vessels (*vasa efferentia*) from both groups converge toward the large oval-shaped aperture (*fossa ovalis;* saphenous opening) in the deep fascia of the thigh (*fascia lata femoris*), through which they pass to gain the deep subinguinal glands (*l. subinguinalis profundae*), situated on the medial side of the femoral vein (*v. femoralis*), and numbering usually not more than three. The deep glands also receive the afferent vessels from the clitoris and associated structures. The highest one of these glands (node of Cloquet; of Rosenmuller) is situated in the femoral ring (*annulus femoralis*). The group as a whole is continuous with an extensive chain of parietal pelvic glands grouped in relation to the common iliac artery, and its two branches, and accordingly named the external iliac, the hypogastric, and the common iliac glands—all of which are connected by numerous anastomoses. The pelvic glands send their efferent vessels upward to a large group of intercommunicating lumbar glands, which because of their positions in relation to the abdominal aorta, are called pre-aortic, retro-aortic, and lateral aortic glands; the efferents of the aortic glands end in the *cysterna chyli* of the thoracic duct (*ductus thoracicus*), opposite the second lumbar vertebra.

The lymphatic vessels from the pelvic organs terminate chiefly in the hypogastric and the iliac glands; a smaller number end in the aortic, and relatively few in the inguinal glands. Those from the bladder pass to the external iliac, the hypogastric, and the common iliac glands; those from the urethra and the intrapelvic part of the ureter, to the hypogastric glands. The efferent vessels from the cervix of the uterus and from the major portion of the vagina drain, as do those of the urinary bladder, into the three groups of pelvic glands; those from the lowermost part of the vagina, however, descend to join those of the pudendum and pass to the superficial inguinal glands. The majority of the vessels from the fundus and the cervix of the

[1] This and certain of the iliac groups of glands are not recognized in the B N A.

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fossa of the perineum through the lesser ischiadic foramen. As the pudendal nerve enters the ischiorectal fossa its first important branches are the inferior hemorrhoidal nerves[1] which accompany the hemorrhoidal vessels medialward to supply the external anal sphincter muscle and the integument around the anus. The pudendal nerve divides into two terminal branches, the perineal and the dorsal nerve of the clitoris, near the posterior margin of the urogenital diaphragm. The perineal nerve sends superficial branches forward which, entering the superficial perineal compartment as the posterior scrotal nerves, pass in company with the corresponding arteries to the skin of the labium and of the anterior part of the perineum. The deep division of the perineal nerve is mainly muscular, since it supplies all the muscles in both the anal and the urogenital portions of the perineum. In the anal triangle, fibers are sent to the levator ani and to the external anal sphincter muscles; the nerve then pierces the base of the urogenital diaphragm, and, entering the deep perineal compartment, is distributed to the deep transverse muscle and the urethral sphincter; other fibers, reaching the superficial compartment, supply the superficial transverse muscle, the ischiocavernosus and the bulbocavernosus muscles. The dorsal nerve of the clitoris enters the deep compartment at the anterior end of the canal of Alcock in the obturator fascia; with the dorsal artery it traverses this space and, piercing the inferior fascia of the urogenital diaphragm, courses forward on the dorsum of the clitoris to the glans; it contributes fibers to the sympathetic cavernous plexus (*plexus cavernosus clitorides*) which supplies all of the erectile tissue.

The integument of the perineum, in addition to the fibers received from the posterior labial nerves, is also supplied by the following: The anterior labial branches of the ilio-inguinal nerve; the external spermatic branch of the genitofemoral; the perineal branches of the posterior femoral cutaneous nerve; the perforating cutaneous branches of the second and third sacral nerves; the perineal branch of the fourth sacral, and the anococcygeal nerves. The ilio-inguinal nerve (*n. ilio-inguinalis*) is derived, through the lumbar plexus, from the first lumbar nerve; within the abdomen it emerges from the lateral border of the psoas major muscle, crosses the quadratus lumborum muscle to enter the pelvis major. Here it extends forward on the iliacus, to gain the anterior abdominal wall, the musculature of which it pierces to gain the subcutaneous inguinal ring and the front of the thigh, where it sends the anterior labial nerves (*nn. labiales anteriores*) to the integument of the mons and the labia. The genitofemoral nerve (*n. genitofemoralis;* genitocrural) has a similar origin; it usually follows the course of the round ligament through the length of the inguinal canal, and gives cutaneous fibers to the labium. The posterior femoral cutaneous nerve (*n. cutaneus femoris posterior;* small sciatic) arises from the sacral plexus, receiving fibers from the first to third sacral nerves; it leaves the pelvis through the greater ischiadic foramen below the piriformis muscle; descending beneath the gluteus maximus muscle, it passes downward on the back of the thigh beneath the fascia lata; the perineal rami (*rami perineales*), destined to supply the skin of the perineum, pierce the fascia a short distance anterior to the ischial tuberosity, and course forward and medialward. The second and third sacral nerves of the sacral plexus

[1] *Nn. haemorrhoidales inferiores* in the Basle Nomenclature—corresponding, as do the names of the succeeding branches, to those employed for the branches of the arteries and the tributaries of the veins.

continuous above with that of the piriformis, and below with that of the levator ani muscle.

The levatores ani muscles, and their investing fasciae, together form the greater part of the pelvic diaphragm, which supports the pelvic viscera and constitutes the partition between the pelvis and the perineum (Fig. 88; compare Fig. 90). Each muscle takes origin in front from the posterior surface of the superior pubic ramus (Fig. 92), lateral to the symphysis, and behind, from the pelvic surface of the ischial spine; between these two points it has an aponeurotic origin, from the tendinous arch (*arcus tendineus m. levator ani*) of the obturator fascia. The anterior fibers which constitute the pubococcygeal part of the muscle pass backward and medialward along the side of the urethra, the vagina and the anal canal, then upward, to be inserted as a tendinous plate into the anterior surface of the third and fourth sacral segments—where it may overlie the coccygeus muscle. The iliococcygeal part of the muscle, made up of the middle and posterior fibers of origin, forms, with its fellow of the opposite side, a median fibrous raphe which extends from the anal canal to the tip of the coccyx. In old subjects the diaphragm may be predominantly fascial, containing relatively little musculature.

The fascial covering on the pelvic surface of the levatores ani and coccygei muscles is the superior fascia of the pelvic diaphragm; wherever a viscus passes through the pelvic diaphragm into the perineum, the fascia is reflected upon it to blend with the outer fibrous coats; and in accordance with the viscera to which it is related, the fascia is termed vesical, uterine, or rectal layer of the endopelvic fascia (*fascia endopelvina*). In extending outward on each side, the layer meets the parietal pelvic fascia covering the obturator internus muscle. This layer of obturator fascia is continuous at the brim of the pelvis minor with the fascial investments of the iliacus and psoas major muscles (Fig. 94); these in turn continue medialward to cover the front of the sacrum and of the lumbar vertebrae. Along the whole length of the iliac crest, at the entrance to the pelvis major, the iliac fascia is continuous with the transversalis which forms the general fascial lining of the abdominal parietes (Fig. 92). Between the fascia and the peritoneum, as has been described, lies the extraperitoneal fatty tissue, which in the pelvis minor fills the considerable space housing all of the viscera and their vessels and nerves.

the ostrich. The iliac bones are firmly united with the vertebral column and serve as a firm support between the lower extremities and the body. The united, elongated and slender pubic bones give room, in the oval-shaped outlet, for the passage of the egg. In all birds and in the porcupine ant-eater, the acetabulum is perforated.

There is great variation in the degree of pelvic development in the mammalian pelvis. The ischial bones are the most constantly present. A peculiar variation is seen in the Monotremes and the marsupials, in which there is developed the marsupial bone which is the ossified inner tendon of the external oblique muscle of the abdomen. This serves to support the marsupium, as it is found in the kangaroo. In some aquatic mammalia, as the whales, dugongs, and manatees, the pelvis is very rudimentary. Due to the lack of physiologic demand for actively functioning lower extremities, the ilium is lacking, and loosely attached ischial and pubic bones are found. In the Chiroptera and other insectivorous mammals, there is an elongated pelvis which remains wholly ununited at the symphysis, except by a ligamentous band in some varieties. The bats are the only land mammals which do not support themselves upon their lower or hinder extremities, which they use only in flight and for hanging. The hinder extremities take on more or less the character of forelimbs, so that the femur resembles a humerus and the pelvic bones are of an elongated slender build.

Mammalian pelves, in general, are more elongated and narrower than in man. This is well shown in most of the quadrupeds. Pelvic development varies in the different types of quadrupeds, depending in part at least on the distribution of body weight with reference to the pelvis and the lower extremities. There is a marked difference between the pelves of animals which constantly move on all four limbs and those mammalia which assume the erect position readily, frequently, or constantly, when they are in motion. This is shown strikingly in the relationship between symphyseal height and that of the sacro-iliac synchondrosis. The following measurements from Krukenberg illustrate this striking difference and also show that in quadrupeds the symphysis is better developed and stronger than the sacro-iliac synchondrosis:

	Height of symphysis, cm.	Height of synchondrosis sacro-iliaca, cm.
Horse	21.0	6.0
Elephant	35.0	12.0
Hippopotamus	24.0	8.5
Antelope	5.5	2.0
Leopard	6.5	4.0
Kangaroo	6.5	3.0
Squirrel	1.0	0.6
Bear	7.0	6.0
Gorilla	2.0 (ca)	0.5 (ca)
Man	3.5	6.5

The type of locomotion affects the pelvic development and the bony attachments considerably. Where movement, propulsion and weight bearing are largely the function of the hinder or lower extremities, the sacro-iliac synchondrosis is relatively strong and well developed. The attachment of the trunk to the pelvis in these types of animals is especially strong; this is

well developed, the transverse midplane is deeper and the ischium has a broader and flatter surface.

Physiologic or dynamic pelves of animals are better constructed for easy labors in animals than in man, because they are wide and roomy and the parts are more movable than in the human female. It is also believed that anomalies and contractures of the animal pelves are rare and such as occur are probably due to trauma, exostosis and ankylosis of pelvic, especially of the sacro-iliac, joints.

DEVELOPMENT OF THE BONY PELVIS

Ontogenetically, the human pelvis is supposed to reveal to some extent in the embryologic picture the characteristics of ancestral pelves, and the development presents some phases illustrative of the transition seen in the

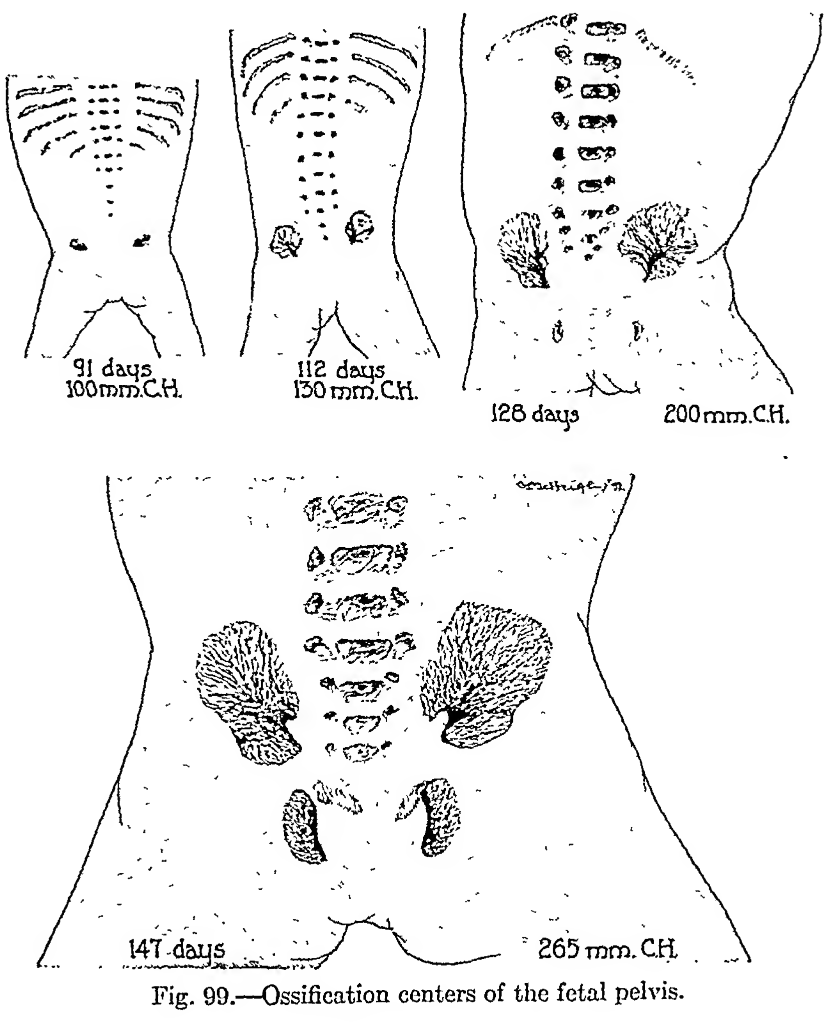

Fig. 99.—Ossification centers of the fetal pelvis.

pelves of the vertebrates from the lower to the higher forms of life. The development of the bony pelvis has been studied microscopically; also in transparent specimens and by means of the x-ray pictures, which give well-defined images of the various ossification centers. The x-ray does not reveal these centers quite as early as they can be demonstrated by microscopical

neural processes. They ultimately form the cornua of the adult coccyx. Costal processes appear only in the blastemal stage, except for the first coccygeal where they, together with the transverse processes, ultimately form the corresponding adult processes. The bones of the pelvic girdle also pass through the blastemal stage and each of the ultimate three bones is represented by a cartilaginous center, which is just visible in an 11-mm. embryo. A miniature cartilaginous pelvis is formed which corresponds somewhat to the adult type. These cartilaginous centers send out processes

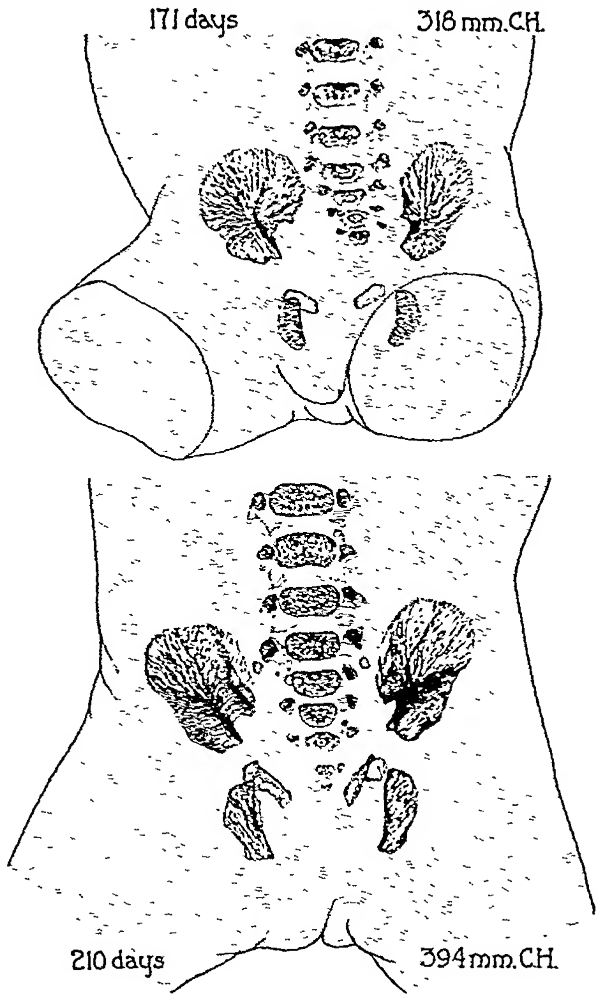

Fig. 100.—Ossification centers of the fetal pelvis.

which unite with others and in embryos of from 15 to 20 mm. form a shallow acetabulum, which gradually deepens during the third fetal month. The cartilaginous ischium and ilium unite before either one fuses with the pubis. The symphysis is formed at the end of the second or the beginning of the third month. Ossification follows closely upon chondrification, both in time and order. The first center appears in the ilium around the eighth week, about a fortnight after the appearance of the first ossification center in the clavicle. There are no membrane bones in the pelvis so that all of the bones in the pelvic girdle pass through the three stages which have been previously

iliac nucleus is apparent. This occurs between the seventy-fourth and seventy-sixth day in embryos with a crown-rump measurement of 51 or 52 mm. The lateral sacral centers put in their appearance between the eightieth and eighty-second day after two or three median centers are present. The sacral centers appear in sequence from above downward and from the midline outward. The last median center comes in between the one hundred forty-second and the one hundred eighty-ninth day, at about which time the nucleus for the first costal process appears, to be followed later by the second and possibly the third pair. There is never more than one coccygeal median center present prior to birth. The axial centers of the pelvis, which are usually visible at birth, are five median sacral and one median coccygeal, five paired centers for the neural arches and usually three pairs of nuclei for the costal processes. The iliac centers show in the x-ray from about the sixtieth to the sixty-fifth day and no secondary centers appear. The ischial nucleus appears from about the ninety-fourth to the ninety-eighth day, while that of the pubes is not apparent before about the one hundred nineteenth day. Practically all of the antenatal centers are present by the nineteenth or twentieth week, though the more distal lateral, the costal and coccygeal centers appear later.

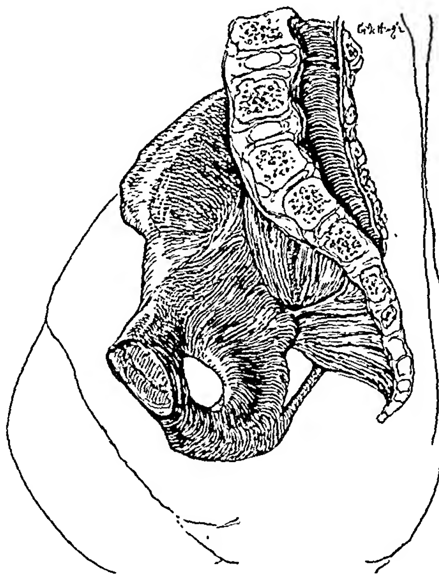

Fig. 102.—Sagittal section of the bony pelvis of an eight-month fetus.

The pelvis of the newly born infant is mostly cartilaginous, but ordinarily shows beginning ossification in the transverse pubic ramus, the ischium and ilium where these nuclei are fusing into a Y-shaped bone near the acetabulum (Fig. 101). These make up the ultimate os innominatum after the appearance of the secondary centers. In all, there are about twenty-four or twenty-five different centers at the time of birth. There are five median sacral and possibly one coccygeal (6), five paired centers for the neural arches (10). In addition there are probably three and possibly more costal nuclei (6). The pelvis of the newly born infant is quite different in its appearance from the adult pelvis. The sagittal section shows a straighter axial skeleton with a less marked promontory and sacral concavity (Fig. 102). The promontory also occupies relatively a higher level.

In cross section the infant's pelvis is more nearly circular with ilia arranged more vertically. The sacrum is narrower and the transverse concavity is more marked. The rami of the pubes are shorter and the arch is more acutely angular. The inclination of the pelvis is greater. The canal is more circular and of a funnel shape. The ratio of the conjugata vera to the transversa is as 100 to 105, the adult relationship being 100 to 122.5. The pelvic outlet shows corresponding relationships as the transverse is relatively narrower, in relation to the anteroposterior diameter, than it is in the adult. At birth the pelvis is mainly cartilaginous with unfused ossification centers

lateral plate on either side, and those of the spinous processes. Union of the neural arches begins about the second and is complete about the sixth year.

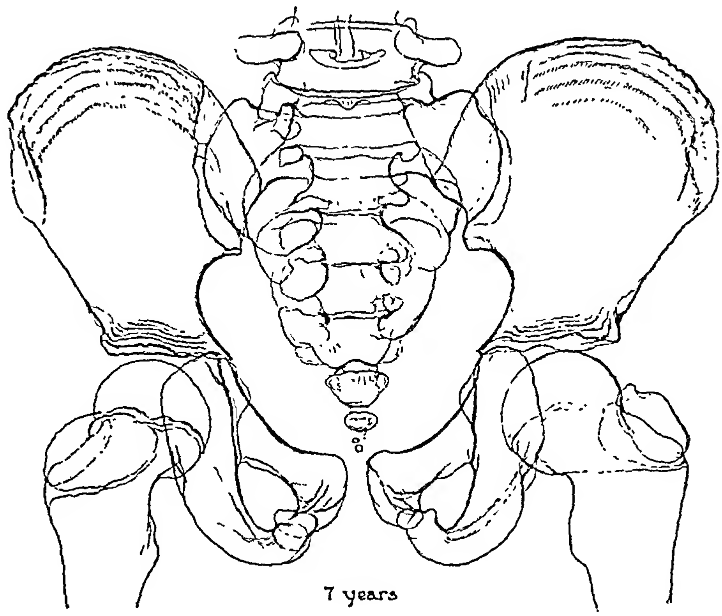

Fig. 106.—Ossification centers of the bony pelvis in childhood.

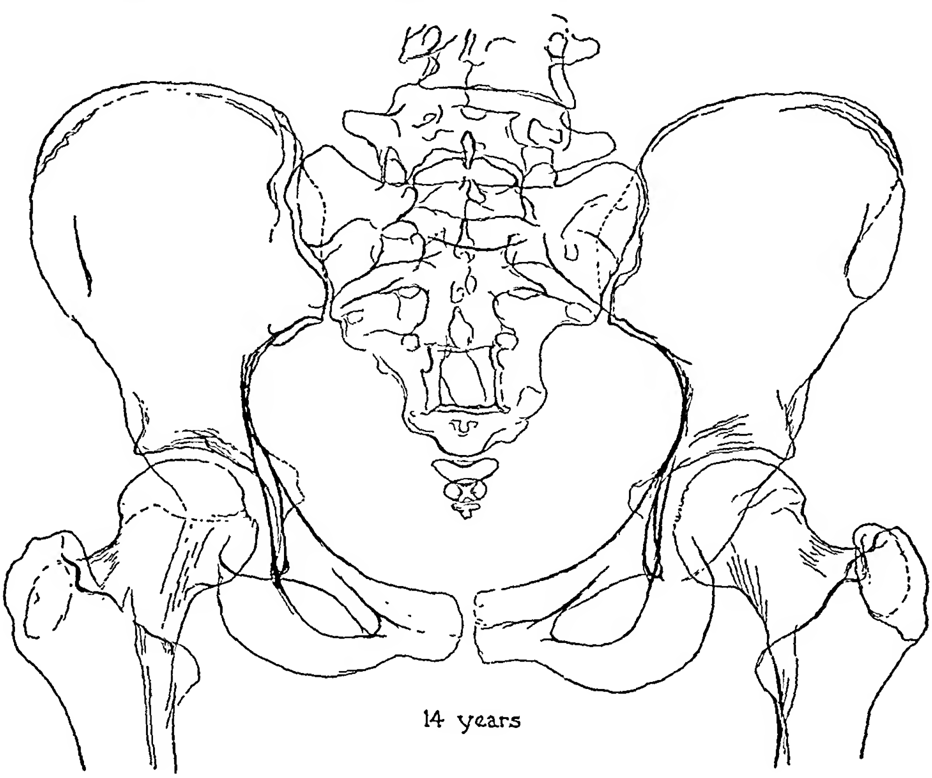

Fig. 107.—Ossification centers of the bony pelvis in adolescence.

The costal processes have fused with the arches at about the fifth year. The lateral epiphyseal centers, which appear between the tenth and the twentieth

years, fuse with the bone at about the twenty-fifth year and the epiphyses of the spines appear and unite somewhat later. The fusion in the coccyx also extends from the tip upward and is not complete until fifty to sixty years. The well-developed iliac, ischial and pubic centers are united by a cartilaginous pelvis at the time of birth.

During the prepuberal period a center is laid down for the acetabular bone which lies at the junction of the three bones, all of which unite shortly after puberty (from fourteen to sixteen years). A whole group of epiphyseal centers appear around different portions of these bones and unite with the main bones between the eighteenth and the thirty-fifth years. The pelvis at birth is vertical, the inlet is circular and the canal straight. There is no promontory and the first sacral vertebra lies above the brim. The foramina are small, the acetabular fossa is large and the subpubic angle is acute. The iliac bones are thick and have no lip on the lateral margin and there are no fossae. The ischial bones are relatively massive. There are no further marked changes in the pelvic form until the infant begins to sit and walk, at which time the still plastic pelvis is subjected to pressure from three main directions—downward pressure through the vertebral column and lateral and upward pressure from either side through the femora. The sacrum is wider anteriorly than posteriorly, a sort of inverted wedge, so that the downward and lateral pressure tend to bring down the promontory which alters the relations between the lumbar and sacral spines. The sacral concavity becomes increased. The force applied laterally and upward is carried to the ilio-sacral joint. There is some play in the iliac fossae which, combined with muscle pull on the crests, tends to bend the ilia outward.

Schroeder has stressed the cohesive force of the ligaments at the pubic symphysis, but it is difficult to see why this is more important than the resisting force of the sacro-iliac ligaments at the synchondrosis. When the infant begins to assume the erect position, the line of the center of gravity is shifted so that it passes in front of the site of the infant promontory. The weight of the body, therefore, presses not only downward upon the sacrum but also forward.

If the sacrum were not firmly held in position by the ligaments and articular surfaces, it would tend to rotate around its transverse axis. This response not being possible, it is bent so that the promontory is formed and the spine approaches the pubes, producing the characteristic shape of the adult inlet. In this process of bending, the deep longitudinal concavity of the sacrum is formed around its axis, which corresponds with the third sacral vertebra. This same pressure tends to push the central portion or bodies of the sacrum forward, thus making the transverse concavity more shallow. The plastic sacrum is more firmly held laterally and posteriorly by the posterior ligaments, which run from the posterior surface to the ilium and to its posterior spines. The pull on this posterior lever tends to swing the anterior portion of the ilium outward. This force is resisted by the cohesion and restraint at the symphysis and by the pressure of the femora. The bending of the ossa innominata occurs in the longer arm of the lever, which is anterior to the sacro-iliac synchondrosis.

The resultant of these forces is a shortening of the conjugata and a lengthening of the transverse diameter, which is approximately longer than it really is. The effect of mechanical factors upon growing pelves is un-

dominate the development of pelvic types. Differences are demonstrable in fetal life and Hess, Adair, Baer and others have shown that pelvic ossification proceeds more rapidly in females than in male fetuses. It is probable that differences in chondrification also exist, but they are more difficult to demonstrate. The earlier appearance and somewhat more rapid growth of the ossification centers in the female than in the male fetal pelvis accord with the general plan of skeletal development. There does not appear to be so much difference in the form of the pelvis of male and female infants and children until the rapid development of the female type of pelvis, which occurs and is associated with development at the time of puberty. The acceleration of growth in girls has already been mentioned.

In the adult the fully developed pelvis of the male differs considerably from that of the female (Figs. 110, 111). The usual external measurements are not markedly different except the interspinous, which is considerably

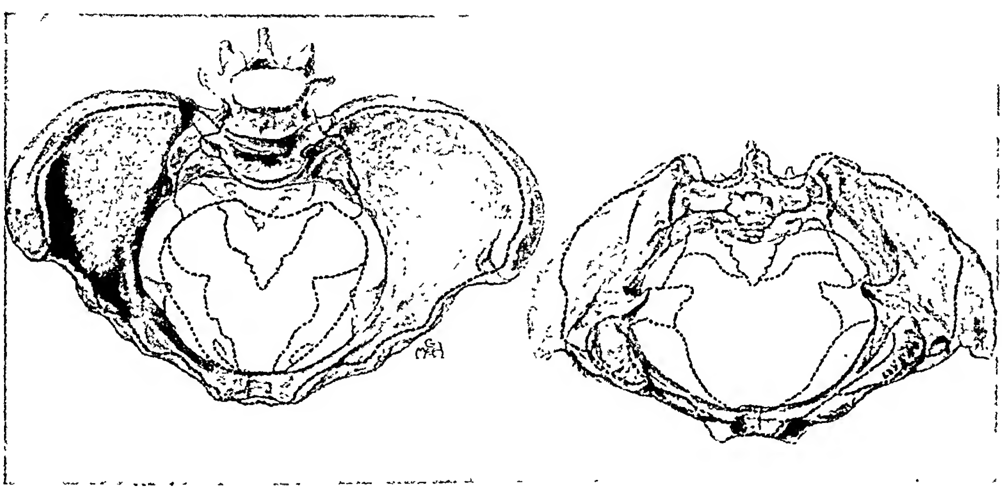

Fig. 111.—Views of female pelvis with male pelvis superimposed in dotted outline.

longer in the female. In general, the bones are thicker and heavier and have more marked areas for muscular attachments in the male. The false pelvis exhibits more of a shallow basin in the female. The true pelvis shows a smaller and more funnel-shaped canal in the male. The various diameters, especially those of the outlet, are distinctly shorter in the male pelvis.

Comparison of various diameters of normal pelves by Litzmann's decimal method (Williams).	Diameters.		
	Anteroposterior.	Transverse.	Oblique.
Superior strait	100.0	122.7	113.0
Plane of greatest pelvic dimension	115.0	113.6	
Plane of least pelvic dimension	105.5	95.5	
Inferior strait	105.5	100.0	
Comparison of male and female pelvic diameters in cm.			
Superior strait			
Male	10.5	12.5	12.00
Female	11.0	13.5	12.75
Inferior strait			
Male	9.5	8.0	
Female	11.5	11.0	

the pelvis to its function not only in man but also in some of the lower animals. It has seemed of value to bring out the adaptation of the pelvis to the needs of some of the different species of animals and to the requirements of different races of man. The sexual differences illustrate a very definite adaptation to the varying physiologic needs of male and female in regard to the generative organs and the performances of their functions.

The development of the bony pelvis has been described rather briefly, but with the idea of showing how the normal development proceeds. It is easy to understand how any interference with the growth or development of part or all of the pelvis, or of related parts, may produce an abnormal pelvis. The mechanistic idea has been carried too far by some as an explanation for the development of the form of the pelvis, but it is undoubtedly a factor in producing the normal adult form of pelvis and in causing certain variations from the normal which lead to some of the various types of deformed pelves which will be considered in detail in another chapter. Before describing the obstetric pelvis of the human female, it will be of some interest and value to give a brief sketch of the development of our knowledge, relative to the history of our conceptions regarding the anatomy and physiology of the bony and ligamentous pelvis.

HISTORY OF THE BONY PELVIS

An understanding of the anatomy and physiology of the bony pelvis and the soft parts was naturally essential to any comprehension of the physiology and mechanism of labor. At the time of Hippocrates, it was believed that the fetus was an active agent in propelling itself through the inactive pelvis and soft parts. It was further thought that it was necessary for the fetus to come head first, as it was believed that the feet were braced against the mother as the fetus forced its way out. This conception lead to mutilating operations for the delivery of the fetus. Celsus and his school demonstrated the fallacy of this belief and showed the possibility of breech extraction, which led to the establishment of version in the time of Soranus and Moschion. The fetus became a passive agent in the process of delivery, but still there was no contribution, so far as we know, to the mechanism of labor and the bony pelvis. Avicenna and the Arabian school contributed nothing except some theoretical considerations. The obstetric art and science lay dormant and retrogressed in that much which had been previously learned was forgotten during the Dark Ages, and strong religious and other prejudices hampered the progress of medical knowledge, particularly with reference to midwifery.

It was a well-established idea that the pelvis underwent changes which led to a separation and gaping of the bones, with an increase in size of the pelvic cavity. The occurrence of this change was considered essential for the birth of the infant. Such a conception may well have originated from the observation of pelvic mobility in some of the lower animals. The pelvis of man and those animals which assume the erect posture has been shown to be more rigid than those of other types of animals. The anatomical study of the body and consequently of the pelvis led to a much better and more exact understanding of the pelvis.

Much progress was made, beginning with the sixteenth century, when Vesalius (1514–1564) accurately described the bony pelvis and demonstrated

through the pelvic cavity parallel to the plane of the inlet, which he designated as the first parallel plane. His second parallel plane coursed through the pelvis from the lower margin of the ligamentum arcuatum to the middle of the second sacral vertebra and is synonymous with corresponding planes described by Zweifel (1848–1927) and Veit (1852–1917). The third and fourth planes of Hodge pass respectively through the ischial spines and the tip of the coccyx. His frontal planes pass perpendicularly to the planes of the inlet through the ischial spines and the ischial tuberosities respectively.

Michaelis (1798–1848) established the idea of the conjugata vera as the median anteroposterior diameter running between the most prominent point on the sacral promontory and the nearest point on the inner surface of the pubic symphysis. This point usually lies about 0.5 cm. below the upper margin of the symphysis. Litzmann (1815–1890) utilized the conjugata vera as a method of expressing the size of the other pelvic dimensions, *i. e.*, 100 by 11 cm. Breisky (1832–1889) utilized the greatest transverse diameter of the pelvis for the same purpose. It was shown by Schwegel, Walcher, and others that by posture the conjugata vera and the anteroposterior diameter of the outlet could be increased approximately 1 cm. Balandin believed that the outlet was increased during the process of labor. These increases were accomplished mainly by elasticity of the joints and especially of the sacro-iliac articulations. This stretching of the joints could also increase the transverse diameter of the inlet by about 1.5 cm.

The determination of the inclination of the pelvis and of the axis of the parturient canal received much attention during the eighteenth century. There was some diversity of opinion, and Naegele (1771–1851), after extensive study, concluded that the angle of the plane of the inlet to the horizontal was about 60 degrees on the average.

Meyer (1815–1892) conceived the normal conjugate, which line he projected across the upper margin of the symphysis to the angle of the third sacral vertebra. He maintained that this diameter had a fairly constant relation of about 30 degrees to the horizontal when the woman was in the erect position. He estimated the pelvic inclination to be about 54.5 degrees. While Huwé was the first to recognize the inclination of the pelvis, Müller was the pioneer in measuring it. He thought that the angle was 45 degrees.

Deventer first called attention to the direction of the pelvic cavity, but Müller used the designation "axis of the pelvis" for the first time. He and, later, Camper (1722–1789) conceived of the axis of the pelvis as a line drawn from the navel through the middle of the conjugata to the tip of the coccyx. Roederer constructed the pelvic axis from the outlet upward so that a line passing through the middle of the outlet would pass upward to about the promontory. These two axes would meet and naturally the conception of an angulated or curved pelvic axis arose, which idea became incorporated in the curve of Carus, which represents a projected line through the midpoint of innumerable planes passed through the pelves from symphysis to sacrum and coccyx. Levret and others conceived of three axes but not all had the same conception of them.

It was also believed that a center on the head followed a curve through the pelvis which could be regarded as the pelvic axis. Such a head center could follow a line of direction through the pelvis, but the resultant line could not be regarded as an axis. The head could not rotate around a given

among the strongest in the body, but in the female they must yield slightly to pressure but not sufficiently to permit injury with loss or impairment of function, which sometimes occurs from sacro-iliac injury of varying degrees. Other ligaments add to this support; the principal ones are the sacrospinous which complete the greater ischial foramen and separate it from the lower-lying lesser ischial foramen, which has the powerful sacrotuberous ligament on its posterior and inferior margin (Figs. 112, 113).

Some of the interior ligaments extend across the pelvic facies to bridge over the obturator foramen by the membrane through the upper portion of which the obturator canal passes. Anteriorly, the pubic facies of either side is covered with layers of hyaline cartilage and between the two there is a layer of fibrocartilage. The ligamentous supports of this articulation are not so very strong but consist of a superior pubic ligament and the inferior arcuate ligament.

Both the pubic symphysis and the sacro-iliac synchondrosis have small joint cavities, which are larger in women than in men. It is also believed by many that there are changes in these joints and ligaments during pregnancy and labor. These alterations increase the elasticity and, to a slight extent the mobility of these joints. Such changes make possible some of the complications which arise in these articulations during pregnancy and labor. They also facilitate the temporary enlargement of the pelvic diameters by means which may be employed, as in the Walcher position, for increasing the anteroposterior diameter of the inlet, and in the Sims and the squatting posture for increasing the outlet.

THE OBSTETRICAL PELVIS

The major interest of the obstetrician centers in the true pelvis and not so much in the pelvis as a whole or in the false pelvis. The interior of the pelvis is of much greater importance to him than the exterior, but the latter is more accessible and gives information of value relative to the internal pelvis. The knowledge of the complete pelvis with all its tissues in place is of much more value to the obstetrician, as it is this with which he deals in practice. Nevertheless, variations of the bony pelvis cause changes in the other relations and have a very direct and indirect bearing on obstetrical practice.

The measurements of the bony pelvis are important, as they give the size of the more or less rigid canal through which the fetus is born. On the other hand, the actual diameters are those with the soft parts in place, and the measurements which the obstetrician makes are upon the living subject. In general, the external measurements taken by the physician upon the patient are greater, while the internal measurements are less than those made upon the bony pelvis. It is unnecessary to discuss pelvimetry in this chapter as that will be considered elsewhere, but the important obstetrical measurements of the bony pelvis will be given (Figs. 112, 113).

The external measurements considered to be of importance are: the interspinous, which is the distance between the anterosuperior iliac spines, 25 ± cm.; the intercristal, which is the distance between the outer lips of the iliac crests at the widest part, 28 ± cm.; the external conjugate or diameter of Baudelocque, the distance between depression just below the spine of the last lumbar vertebra and the anterosuperior surface of the pubic symphysis, 20 ± cm.; the right external oblique, or the distance between

external measurements show no close relationship to the size of the true pelvis, but they do give a fairly definite idea of the general size, the form and the type of pelvis with which one has to deal. The true pelvis lies below the inlet or brim which is outlined by the sacral promontory, the linea terminalis and the upper border of the horizontal pubic rami, body and symphysis. The borders do not lie exactly in one plane, but one speaks of the plane of the inlet which divides the false from the true pelvis.

The diameters of the pelvic inlet are of great importance. They are the conjugata anatomica, which is about 0.5 cm. longer than the conjugata vera,

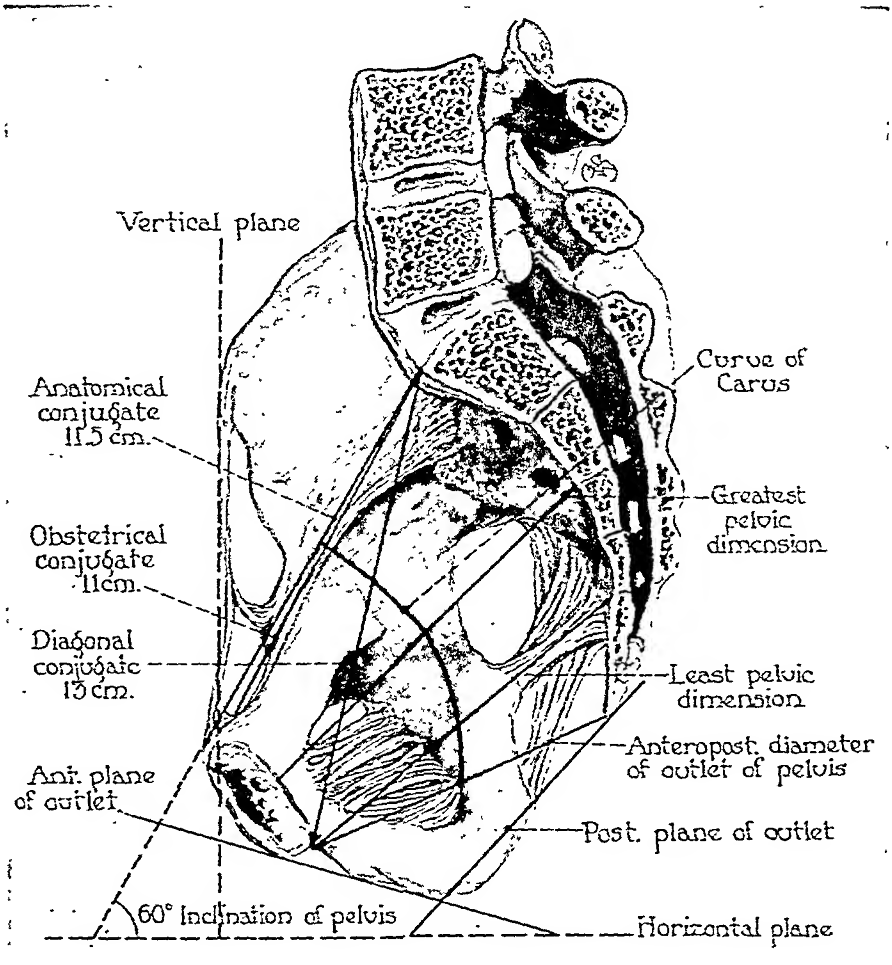

Fig. 114.—Sagittal section of bony and ligamentous pelvis with anteroposterior diameters of various pelvic planes.

or obstetrica (11 cm.). This diameter is the shortest distance from the sacral promontory to the upper portion of the inner surface of the pubic symphysis in the midsagittal plane. Another diameter, not strictly of the inlet but associated with it, is the conjugata diagonalis (13 cm.), which is the distance from the point on the promontory mentioned above to the apex of the pubic arch. It is of great value in estimating the size of the conjugata vera, which is 2 ± cm. less than the diagonal conjugate (Fig. 114).

planes, one of which is bounded by the inner surfaces or lower margins of the arcuate ligament, the vertical rami of the pubes, the rami and tuberosities of the ischial bones. This anterior plane makes about a 13-degree angle with the horizontal plane. The posterior plane is bounded by the ischial tuberosities, the sacrotuberous ligaments and the tip of the coccyx. It forms an angle of about 32 degrees with the horizon. It is seen that the two planes meet in an angle of about 155 degrees on their upper surfaces. The diameters of these planes are more important than the anatomical measurements of the inferior strait. Not only are the individual measurements important, but their relationship to one another is especially significant. This applies particularly to the relative lengths of the transverse and posterior sagittal diameters.

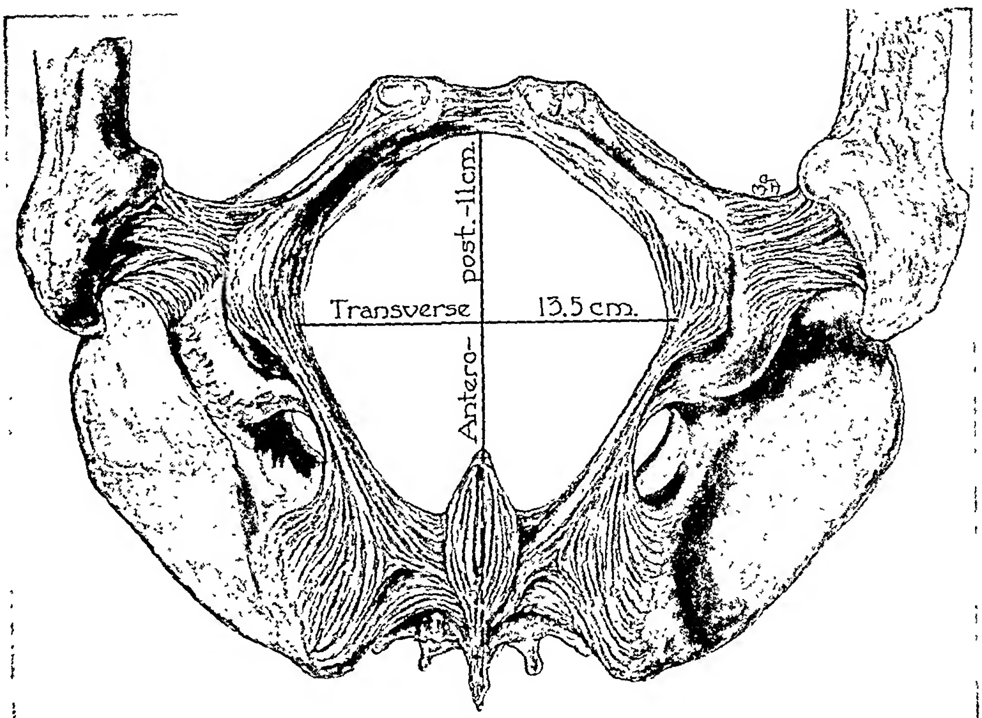

Fig. 115.—Outlet of bony and ligamentous pelvis with diameters.

The sagittal diameter of the anterior plane is about 6 ± cm. and that of the posterior plane equals 7 ± cm. The outlet measurements of the bony pelvis are very important and the relationship of the transverse and posterior sagittal diameters is especially significant in determining whether or not the fetal head will meet obstruction at the outlet. Anomalies of the outlet may appear in pelves otherwise normal and, according to Williams, are among the most common types of pelvic deformity in white, American women.

In order to appreciate the importance of and associate the diameters of the various pelvic planes with the mechanism of labor, the measurements of the fetal head will be given. The head, in passing through the parturient canal, tends to present its most favorable circumferences and diameters and to adapt the longest diameters to the longest pelvic diameters at the various levels which it occupies. The head presents one or another of its antero-

ter I, is important for a proper understanding of the physiology, pathology, and treatment of immediate and remote results of child-bearing. The diagnosis and surgical treatment of many diseases of the female genitalia are dependent upon a proper knowledge of the regional and surgical anatomy of these parts.

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SECTION II

PHYSIOLOGY OF THE REPRODUCTIVE ORGANS (EXCLUSIVE OF PREGNANCY)

CHAPTER III

HISTORICAL REVIEW

By Emil Novak, M. D.

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So active has been the study of the female reproductive cycle in recent years, and so extensive has the literature become, that the medical student of today can scarcely appreciate that almost up to the beginning of our own century very little indeed was known as to the physiology of the sex cycle. It is no exaggeration to say that more has been learned concerning this subject within the last thirty or thirty-five years than had been learned in as many centuries preceding. And yet the phenomenon of menstruation has always engaged the interest of medical men, from the very earliest times to our own day. But for centuries it was shrouded with a mantle of mysticism which engendered superstition and speculation rather than scientific study.

The earliest concepts of menstruation attributed to the phenomenon a cleansing or purifying function. According to this belief, reflected in the old Greek name for menstruation (*κάθαρσις*, catharsis), the purpose of the periodic flow was to rid the woman's body of harmful or poisonous humors. This idea, entrenching itself in the folk-lore of the centuries, has not yet been dislodged, from the lay mind at least, as every practising physician knows. It is responsible for the taboo placed upon menstruating women in the past in both civilized and uncivilized countries, and, in the latter more particularly, even to this day. Innumerable superstitions are based on this idea, and its rich folk-lore is a fascinating one indeed. Some of this superstition and folk-lore I have brought together in a paper published some years ago, to which reference may be made by those who may be interested.

In this paper there were reviewed also the three chief theories held by the medical profession of an earlier day as to the cause and significance of menstruation. These were: (1) the "uterine ferment" theory of Democritus, according to which a mythical ferment (*fervor uterinus*) was considered to boil over, as it were, at regular intervals, with the production of menstruation; (2) the "plethora" theory of Galen, which assumed that menstruation is a sort of physiologic blood-letting to relieve the assumed plethora of all women; and (3) the lunar theory, according to which it is the cycle of the moon which is responsible for the periodic cycle of women.

Of these three ancient theories, the last mentioned is perhaps the most interesting to us at the present day, in spite of its apparent absurdity. In a recent paper I pointed out that "one could almost make out a case for it

teenth century. The indispensability of the ovaries to the sex cycle was demonstrated easily enough by the abolition of the cycle following castration. The persistence or reestablishment of the cycle following transplantation, or implantation, of the ovaries in castrated animals further confirmed this fact, and at the same time proved that the influence of the ovaries was not exerted through their nerve connections, as Pflüger had believed, but that it was dependent upon some substance given off into the blood stream. This, as already stated, marked the beginning of the modern hormone concept of menstruation.

Then there began the long discussion, not yet at an end, as to the ovarian constituent responsible for this hormone effect. The extremely important studies of Fraenkel (1903) pointed to the importance, in rabbits at least, of the corpus luteum in the production of the cycle and in the implantation of the ovum in the uterine mucosa during the first third of gestation. As was true of other investigations on the lower animals for many years thereafter, these studies were too readily applied to the human problem, with much resulting confusion. The next important advance was made by Hitschmann and Adler (1908) in their demonstration of the cyclical changes occurring in the endometrium at different phases of the menstrual cycle.

There then followed a long series of studies, on the part of many investigators (Schroeder, Meyer, etc.), through which the correlation of the ovarian and endometrial cycles was established, histologically and chronologically. One important by-product of these studies was the establishment of the time at which, in the human cycle, the ovum is expelled from the follicle. Up to this time, it may be emphasized, practically all the important advances had been the result of studies in gynecological and obstetrical laboratories, while anatomists and physiologists had shown only a cursory interest in the problem of reproductive physiology.

With the discovery of the vaginal smear method for the chronological study of the cycle in the lower animals, through the work of Stockard and Papanicalaou in 1917, the experimental study of the cycle was given an enormous impetus, and anatomists and physiologists have since then contributed the bulk of our newer knowledge of the subject. The next salient advance, perhaps, was the demonstration, by Frank, and Allen and Doisy, of the physiologic activity of the ovarian follicle hormone and of its dominating importance in the female sex cycle, of the lower animals at least. Here again there was an unfortunate tendency to extend to the human problem the results of studies upon lower animals, with again a resulting confusion for some years.

On the basis of histologic studies alone, some of us had urged for years that the human and the lower animal cycles exhibit important differences, that in the former the follicle hormone could scarcely produce the entire endometrial cycle, and that in all probability another hormone, produced by the corpus luteum, was responsible for the so-called "secretory phase," lacking in the nonfertile sex cycle of the lower animals. In other words, the histologic evidence pointed to a follicle phase and a luteal phase in the human cycle.

The scientific corroboration of this view did not come until 1928, when Corner and Allen were able to extract, from the corpus luteum of rabbits, a substance to which they gave the name of progestin, with exactly the effects

CHAPTER IV

CLINICAL CHARACTERISTICS OF NORMAL MENSTRUATION

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Introduction.—More and more evidence is accruing to indicate that menstruation is not merely a pelvic phenomenon, but that it is associated with a more or less profound periodic physiologic activity of the entire organism. For example, the participation of such distant organs as the hypophysis, thyroid and suprarenal would indicate how far-flung this process is. It should of course be understood that, in the case of the endocrine organs mentioned, we are not justified in speaking of their participation as secondary to the periodic phenomena in the pelvis, for, as a matter of fact, the evidence now indicates that both alike are produced by some unknown periodic urge in living tissue generally. Certainly, in the case of the hypophysis, it seems to be the latter which exerts a dominating rôle over the ovary, rather than vice versa.

SUBJECTIVE PHENOMENA OF MENSTRUATION

The common lay expression "being unwell," as applied to the menstruating woman, is an indication that the process is frequently accompanied by subjective discomfort of one kind or another. There are many women who appear to suffer no discomfort whatever, except for the annoyance of the flow itself, while others, even in the absence of pelvic pathology of any kind, exhibit severe systemic and local symptoms at this time. It is exceedingly difficult to know where to draw the line between the normal and the pathologic, especially if we extend the latter term to embrace the general constitution, the nervous system, and the psyche. The subjective symptoms experienced by the normally menstruating woman are often grouped together under the designation of *menstrual molimina.*

Pain is not a symptom of normal menstruation, although there is often a sensation of heaviness in the lower abdomen. While not to be looked upon as a normal accompaniment of the flow, it is true that many women with no demonstrable local or constitutional abnormality suffer a greater or less degree of actual pain, in some cases severe or even excruciating. Cases of the latter type are of course to be looked upon as pathologic, even though the mechanism is often not clear. A moderate degree of pain, however, may be seen in cases entitled to be considered normal.

Many statistical studies have been made to determine the degree of physical discomfort suffered by the menstruating woman. Some of these, however, are vitiated by the fact that they take no account of the anatomical findings in the pelvis, so that they can scarcely be considered as really representing normal conditions. Chisholm,[5] for example, found that only 23 of a series of 100 women of the industrial and professional classes were free from pain, although only 3 suffered enough to be incapacitated. However,

Many of these are of little value scientifically, some having disregarded the necessity of scientific controls in the observations, and others having been made upon series of patients probably including many who were not in normal health.

It is not surprising, therefore, that the results have been very variable. Von Ott,[40] in 1889, presented his observations on 57 women during 68 menstrual periods, and concluded that, in conformity with the wave theory, the body temperature, pulse rate, blood pressure and muscle power increased before and decreased during the flow. Many other authors have reached similar conclusions (Gebhard, Schröder, Bumm, Tobler, etc.), while Viville[39] and others were able to detect no such cyclical variations when the study was properly controlled.

Body Temperature.—Viville,[39] in an examination of 47 patients, found the temperature to be unchanged in 44, slightly raised during menstruation in 1, and lowered in 2. The majority of investigators, however, have found the temperature to be slightly elevated in the premenstrual period and to drop during menstruation (Kersch, Cullis and Oppenheimer). The variations in the normal woman are very slight, usually only a fraction of a degree. In certain pathologic conditions, however, and especially in tuberculosis, the premenstrual rise is often quite pronounced, and constitutes a diagnostic sign of great importance, as was first pointed out by Riebold. In the same way, a postmenstrual rise is a prognostic sign of some importance in tuberculosis, indicating an unfavorable reaction to the disease.

Pulse Rate.—As far back as 1842 Brierre de Boismont studied the effect of menstruation upon the pulse rate in a group of 104 women. In 62 patients there was a slight acceleration of the rate, and in 14 a striking increase, while the remaining 28 showed no change. The results of this early study, however, have not been generally confirmed by subsequent investigators. Zweifel, for example, found the pulse to be slowed during the period, after an acceleration during the premenstrual phase. Somewhat similar results were obtained by Balard and Sidaine, except that these authors found the acceleration to persist into the first day of the period. Finally, a third group of authors, notably Viville[39] and Schmotkin,[35] were unable to detect any characteristic effect of the menstrual cycle upon the pulse rate.

Blood Pressure.—Most authors have accepted the view that during the period there is a characteristic, though slight, drop of blood pressure, preceded by a slight elevation before the flow. This view is expressed in the earlier investigations of von Ott (1889), Jacobi (1877) and others. Giles, somewhat later (1891), found the pressure to be highest at the onset or on the first day or two of the flow, and lowest at the end of the period. Wiessner (1899) likewise found a characteristic drop in the pressure during the flow. Amos, in an apparently carefully controlled study upon 12 patients, concluded that there is a rise of pressure of from 10 to 15 mm. of mercury during the flow, followed by a rapid fall thereafter. Finally, as with the factors of body temperature and pulse rate, Viville concluded that menstruation exerts no effect upon blood pressure, a view in which he has been corroborated by the equally negative results of King.

Muscle Power, Knee-jerk Reflex.—Since many women during menstruation complain of weakness and lassitude, the question arises as to whether the monthly period entails any actual diminution of muscle power. Schmot-

Numerous statistical studies have been made upon the question of the menstrual tempo, but, as with so many other aspects of the menstrual phenomenon, it is almost impossible to eliminate inaccuracies because of the difficulty of separating the normal from the pathologic. These studies, however, give one at least a working idea of the various types of menstrual rhythm.

The twenty-eight-day type was found by Kelly to constitute 94.2 per cent, by Krieger 70 per cent, by Webster, Hart and Barbour 71 per cent, by Sanes 72 per cent, by Mayer 69.7 per cent. The twenty-one-day type is not uncommon, Kelly finding it in 22 per cent. Less frequent are the cases with intervals of twenty-five or twenty-six days, thirty-five days, and so on. Much more extreme variations are encountered not infrequently, some women perhaps menstruating only once every few months, but such cases are to be looked upon as definitely abnormal.

Duration of Flow.—The widest variations are seen in individual women as regards the duration of the menstrual flow. Schröder gives the average as three or four days, Emmett as 4.82 days, Hirst as three to seven days, Garrigues four days, Montgomery two to eight days, Keating and Coe, four to five days. The study of Sanes[32] upon a large number of women gave three days as the most frequent duration, then four to five days, five days, seven days, and four days. A general rule, to which there are many exceptions, is that a long duration commonly goes with an excessive blood loss, while the scanty flow is apt to be one of short duration.

Amount of Blood Lost.—Here again the factor of individual variation is conspicuous, for every woman is apparently a law unto herself in this respect. In questioning women as to this point, the usual plan is to inquire as to the number of napkins soiled by the patient, although this method is obviously very inaccurate, particularly because of differences in women as to habits of cleanliness. It will, however, usually serve to bring out extremes in the amount of blood loss. From a scientific standpoint, the method most often used has been to determine the amount of hemoglobin recoverable from the soiled napkins, whereby the amount of whole blood can be readily estimated.

The intensity of the flow is not uniform throughout the period. For example, much more blood is usually lost on the second or third day than on the first and last, when the flow is of four-day duration.

The total amount of blood lost during the average flow has been variously estimated. It does not, of course, represent the total of menstrual discharge, for the latter, as we shall see, contains other elements than blood, especially mucin. Hippocrates put the amount of blood loss among Greek women at 20 ounces, and Galen at 18 ounces. Among other older writers von Haller gave the amount at 6 to 12 ounces, Smellie at 4 ounces, Freind at 10 ounces, Astruc at 8 to 10 ounces, and Baudelocque at 3 or 4 ounces. Hoppe-Seyler gives an average of from 26 to 52 cc., while Prussak puts the figure at from 100 to 150 Gm.

Composition of Menstrual Discharge.—As already stated, the menstrual discharge contains not only blood, but also other elements, especially mucin, desquamated and degenerated endometrial tissue, bacteria, and a granular débris. It is usually of dark, venous appearance, and possesses a characteristic disagreeable odor, due partly to the decomposition of blood elements, and partly to the increased secretion of the sebaceous glands of the vulva.

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Japanese girls by Yamasaki fourteen years and ten months, and so on for other countries. These figures all appear to support Engelmann's statement that the American girl is somewhat more precocious in this respect than is her foreign sister. In this connection it is of interest to note that in the original American, the Indian, the age of menstrual onset was found by Holder[18] to be even lower, about 12.9 years. This early onset of puberty he believes is due to the manner of life among the Indians, with its consequent earlier stimulation of sex thought.

Factors Influencing Age of Puberty.—There has been much discussion as to the factors which bring about the wide individual variations in the age of puberty. It is difficult to be certain of the importance of any of these, especially as we are so ignorant of the nature of the underlying impulse which sets the puberty phenomena in motion. For example, Schröder[35] and others believe that race has a definite modifying influence in this respect, although frequently the possible rôle of climate confuses the appraisal of the racial factor. A comparison by Schäffer[34] of the age of the menarche in 1321 gentile girls and 480 Jewesses gave figures of 14.053 years and 13.522 years, respectively.

Another study along these lines was made by Yamasaki[39] upon groups of patients from the five races inhabiting Japan—the Japanese, the Ainos, the Koreans, the Chinese, and the Formosans. Without giving all his figures in detail, his conclusions were that race and manner of life apparently play a more important modifying rôle than does climate. For example, the average age in Korea was seventeen years as against 15.05 years in Japan, although the climate of the former is much warmer than that of the latter.

Engelmann's studies on Arctic Indians and Esquimaux, on the other hand, gave an average age for the menarche of 14.6 years, although here, as compared with the American, it is hard to separate the possible rôles of race and climate. That climate probably plays a part less important than is generally believed is further indicated by the statistics of Currier,[29] who found the age of puberty in Italian girls to average 15.6 years, as against 14 years in the English.

From these and numerous other similar studies which have been made, it would seem that climate plays a less important part than race in the determination of the age of puberty, and that even the racial factor is perhaps not of as great importance as the individual one, which embraces such considerations as environment, education and temperament, exposure or nonexposure to sex stimuli, nutrition, etc.

Underlying Cause of Puberty.—The impulse producing the changes which characterize puberty is generally accepted to be of endocrine nature, and to emanate from the previously inactive gonads. That the latter are completely inactive up to puberty, however, is questioned by many, who believe that the ovary and the testis may possess an endocrine function of manifest importance even in fetal life. The scientific evidence for this belief, however, is very meager. The matter has been further complicated by the recent demonstration of the subordinacy of ovarian function to that of the anterior pituitary. The mere fact that the implantation of anterior pituitary tissue in immature animals can bring about all the phenomena of puberty at once suggests that the hypophysis is the source of the puberty impulse.

The group of distinctive sex manifestations not directly concerned with

of the uterus, undergoes a menstrual cycle of histologic changes, although these are of course quite different from those seen in the uterus. Finally, the *ovaries* present changes of very great significance. Whereas up to this time they are small and elongated, with perfectly smooth surfaces, they now become larger and more rounded. Within a few months of the appearance of the first period, the ovarian surface begins to exhibit irregularities in the form of tiny eminences due to ripening or atretic follicles, or pitlike scars following former ovulations. After all, of course, the onset of ovulation is perhaps the most significant of all the phenomena ushered in by puberty, for it means the beginning of reproductiveness. Around it revolve many of the other phenomena exhibited by the reproductive organs after puberty.

The ovary of the young child, or, for that matter, even the fetal ovary, often shows a greater or lesser number of follicles which mature up to a certain point, but which always become blighted before full maturity. Atretic follicles are therefore common, while corpora lutea never occur except perhaps in the exceedingly rare cases of genuine precocious menstruation, due commonly to pathologic causes. Ovulation does not normally occur until the advent of puberty. Once ovulation is inaugurated, there begins the cycle of follicle maturation, ovulation, and corpus luteum development described in Chapter VIII.

Relation of Puberty to Maturity.—It is a common conception that the capacity for reproduction begins with the onset of ovulation at puberty. This is true only in a qualified way, according to evidence offered by Hartman in a recent paper. For example, in India, where child marriages are so common, the first child is in the majority of cases born the third year of effective marriage. Hartman states that the same relative infertility is seen in monkeys and in mice.

Precocious Puberty.—As already stated, there are rather wide individual variations in the age of puberty, so that there are many normal girls who begin to menstruate as early as ten years of age, or even less. When puberty appears below the age of nine, it is spoken of as precocious. Lenz[24] puts the lower limit at eight years. Only an exceptional case, however, shows menstruation at this early age. Between the ages of eight and twelve, however, a rather considerable group is encountered, numbering 3.5 of all cases, according to Mayer and Krieger, and as many as 5.7 per cent, according to Schäffer.

Distinction Between Precocious Menstruation and Nongenital Hemorrhage of Newborn.—Menstruation is a regularly recurring bleeding, produced by a regularly recurring endocrine impulse emanating from the ovaries. On the basis of these criteria, genuine precocious menstruation is a rare phenomenon. It is not at all rare, however, to encounter cases of genital hemorrhage, occurring only once, in the case of newborn children. Such a phenomenon is often loosely alluded to as precocious menstruation, although its mechanism is entirely different. In the light of the work of recent years, the latter phenomenon is probably due to the accumulation of folliculin in the maternal circulation with advancing pregnancy, and its withdrawal with the delivery of the child and placenta.

Nongenital hemorrhage of the newborn, when it occurs, is almost always seen at about the sixth or seventh day after birth. Its incidence is given variously by different authors. Shukowsky[29] found it in 1 of every 285

of the as yet unknown endocrine mechanism responsible for the normal advent of puberty. In other cases, including most of the cases of extreme degree, as where menstruation occurs at the age of two or three, evidence is usually to be found of some definite pathologic lesion in one or other of the endocrine glands.

In some cases the lesion is present in the ovaries themselves. Guthrie and Emery,[14] Hofacker,[29] and others have reported cases of this type. Most often the lesion is a carcinoma. The cancer is characteristically of the so-called "granulosa cell" variety, as in a case recently observed (unpublished) by Dr. Clarence Ingraham, of Denver, to whom I am indebted for the clinical details and material for histologic study. This patient was a girl of six who, together with evidence of a pelvic tumor, exhibited the development of a mature woman, with normal menstruation, well-developed breasts, and a growth of hair over the mons, vulva and axillary spaces. These symptoms of precocious development all receded after the removal of the ovarian tumor. Histologic study of this tumor showed it to belong to the granulosa cell cancer group. As such tumors possess a folliculoid structure, their capacity to produce a menstruation-like uterine bleeding can readily be understood, just as we now recognize their occasional rôle in the production of similar hemorrhage long after the menopause, in the event of their development late in life.

Types of ovarian tumor other than carcinoma have been reported as responsible for precocious menstruation. Sarcoma was found in Lucas' case, a large cystic ovary in Brohl's, and a malignant ovarian teratoma in that of Harris. It is not easy to understand the mechanism in such cases.

Tumors of other endocrine glands have also been frequently reported. Perhaps most important are those arising in the suprarenal, most frequently reported as hypernephromata. A considerable group of such cases have been reported by Bulloch and Sequeira,[4] and other authors. Tumors of the pineal gland have likewise been reported; Neuman,[29] in 1901, reported 22 cases of this type. Indeed, it is rare not to find a tumor of one of the endocrine organs in cases of menstrual precocity of extreme grade. I can find reference to only 1 such case, that of Prochownik,[29] whose patient menstruated regularly from the age of one year until her death from bronchitis, at the age of three. It need not be added that only the most thorough autopsy will justify the assumption, in any case of this sort, that no neoplasm is present.

Clinical Course in Cases of Precocious Menstruation.—In some cases the abnormal early menstruation continues uninterruptedly up to the time of the menopause. Much more often, however, it is regular for a time, then ceases, and is again resumed at the normal epoch. In the cases in which ovarian or suprarenal tumors were apparently of etiologic importance, the patient was usually restored to normality when the tumor was successfully removed. In other cases the diagnosis of the tumor was made only at autopsy.

The amount and duration of the menstrual bleeding in most cases has been described as like that seen in the normal woman. Menstrual molimina are frequently described, and often hysterical manifestations have been noted at the time of the periods. The mental development of the patient has been described as very defective, almost all authors speaking of the childish type of mind seen in these patients. For example Lenz's patient still played with dolls and very small children at the age of ten.

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15. Halban: Die fötale Menstruation und ihre Bedeutung, Zentralbl. f. Gyn., **28**: 1270, 1904.
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17. Heinricius: Eintritt der Menstruation in 3500 Weiben in Finnland, Zentralbl. f. Gynäk., **7**: 72, 1883.
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19. Joubert: The Supposed Influence of Tropical Climate on Menstruation, Indian Med. Gaz., Calcutta, **30**: 129, 1895.
20. Jump, Bates, and Babcock: Precocious Development of External Genitals Due to Hypernephroma of Adrenal Cortex, Amer. Jour. Med. Sci., **147**: 568, 1914.
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22. Krieger: Die Menstruation, Eine gynäkologische Studie, Berlin, 1869.
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25. Mestitz: Zur Frage der Beziehungen zwischen Keimdrüssen und Geschlechtsmerkmalen, Arch. f. Gynäk., **145**: 662, 824, 1931.
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27. Münzer: Menstruatio praecox und psychische Entwicklung, **51**: 448, 1914.
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29. Novak: Menstruation and Its Disorders, D. Appleton and Co., New York, 4th revis., 1931.
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Contrary to what is apparently the popular belief, the few studies on this subject appear to indicate that the *menopause is apt to be late if puberty has occurred early.* For example, the study of Gallant,[10] in 1910, led him to this conclusion, so that he suggested a "table of expectancy" for the menopause, based on the age of puberty, assuming that the patient is normal.

The influence of *maternity* upon the menopausal age has been studied by Sanes,[25] who concluded that active sexual life, with many childbirths, tends toward a late menopause, while unmarried women are more apt to cease menstruating comparatively early. The influence of *climate* appears rather questionable, as is that of *race.* In general, it seems that women of the colder climates cease menstruating somewhat earlier than those of the warmer zones, while certain races, like the Arabs, are said to show a tendency to unusually early menopause.

Heredity appears to play an occasional part in determining the climacteric age, for it is not rare, in gynecological practice, to encounter several instances in one family of unusually late or unusually early menopause. The influence of *social status* is uncertain, though some believe that the menopause is apt to occur earlier in the hard-working classes than in those living in comfort. The factor of *obesity* in determining an early menopause was formerly much stressed, although it seems certain, in the light of our present knowledge, that the obesity and the disappearance of menstruation, instead of being related as cause and effect, are commonly both the results of an underlying endocrinopathy.

Pelvic lesions may modify the age of the menopause very decidedly, this factor of course being altogether pathologic. In general the menopause is apt to be delayed for a greater or less time by the presence of lesions involving the pelvic organs. An exception to this would of course be noted in the case of bilateral ovarian lesions, especially neoplasms, in which all functioning ovarian tissue is destroyed.

Precocious and Delayed Menopause.—Almost always these are due to definitely pathologic causes, either local or constitutional. For example, I have seen a considerable number of patients who ceased menstruating in the early twenties, but in all these there was an obvious endocrinopathy, commonly associated with obesity.

With regard to abnormally delayed menopause, numerous instances, some quite remarkable, are to be found in the literature, especially in that of an earlier day. Neuman,[21] in 1895, collected instances of the occurrence of the menopause at ages ranging from sixty to one hundred and four, and Battey[23] reported a case in a patient of ninety-three. Pitou[23] described a patient who menstruated six months during her seventy-second year, then became pregnant, and aborted at the second month, the fetus being recovered.

It is difficult to evaluate these older cases properly, but, as has already been stated, they are to be looked upon as pathologic. Within the past few years, attention has been directed to the frequent reappearance of menstruation in women well beyond the normal menopausal age, as a result of the presence of certain ovarian tumors, especially the so-called "granulosa-cell" carcinoma. A considerable number of such cases have been reported. The practical point to bear in mind is that if menstruation persists long beyond the usual time, or, even more, if periodic bleeding recurs in elderly

Nervous Symptoms.—*Vertigo* is a common symptom, as is *headache*. The latter is most apt to be vertical or occipital, and may be very troublesome. *Palpitation of the heart* may be complained of, and occasionally one encounters patients with a *paroxysmal tachycardia*, possibly due to an associated effect of the menopause upon the thyroid. Finally, in rare cases patients may complain of *pruritus*, at times general, at others confined to the genitalia. Here again one must be careful to eliminate such well-recognized causes of this disorder as, for example, diabetes mellitus.

Psychic Symptoms.—These are only occasionally seen, and, when they occur, are usually mild, consisting of *irritability* or of a pronounced tendency to attacks of *depression*. When these symptoms are more severe, there are usually other causes at work, the *psychic instability* of this epoch acting merely in a predisposing or accentuating way.

This is particularly true of "*menopausal insanity*," for, contrary to a prevalent lay belief, the menopause itself is not a cause of insanity. It is true, of course, that many cases of insanity in women occur during the menopausal epoch, but in men also insanity often appears at middle life. In short, the rôle of the menopause in this connection is apparently a predisposing one, actual insanity occurring only in women where other factors, such as heredity, are also present.

Other Symptoms.—*Gastro-intestinal disturbances* are not infrequent during the menopause. There may be *constipation*, and often some *impairment of the appetite*. Some of the older authors spoke of a *dyspepsia uterina* (Kisch)[15] occurring at this age, but it must be remembered that such organic conditions as gallstones, peptic ulcer, and gastric cancer are most common at middle age in both sexes, and the possibility of their presence should always be borne in mind when marked digestive symptoms are complained of.

Skin eruptions of one form or another are not rare. Urticaria, often of a persistent and troublesome type, is at times encountered, as are erythema and acne. There is no characteristic effect upon the *libido sexualis*. Certainly it is not invariably diminished, and, for that matter, it may become markedly increased. The explanation for this, no doubt, is that with the cessation of the menstrual function the fear of conception is removed, and it is this fear which is responsible for many cases of sexual frigidity.

Factors Influencing Severity of Symptoms.—As already stated, women exhibit marked individual variations in the severity of the menopausal symptoms, and similar variations are seen in individual women at different times. While the menopause is a natural and physiologic phase of life in all women, it may under certain conditions assume pathologic proportions. This is particularly true in the case of women who approach this period in a subnormal state of mental or physical health, or who, during its progress, are subjected to undue mental, emotional or physical stress. This idea is so well summarized by Currier[5] that I can do no better than quote him. He states that "All that tends to develop and strengthen the physical part of woman—to render her insensitive to the ordinary ills of life, to make her forgetful of self—is favorable to a normal menopause. Races and nations which are phlegmatic, cold and apathetic, women who are inured to out-of-door life and severe manual labor, savage and barbarous women, peasants, Germans, Scandinavians, and Russians, are apt to complain little of the experiences of the menopause; while the sensitive passionate nations, like

The longitudinal rugae of the mucous membrane become less conspicuous, and the lining epithelial cells become lower.

The cilia may persist for many years after the menopause, although they ultimately disappear.

The *uterus* undergoes marked retrogressive changes in both the cervix and the corpus. The former becomes smaller and shorter, so that in old women it forms only a small button-like projection in the vaginal vault. The corpus likewise shrinks to one half or even one third its mature size, as a result of the disappearance of muscle tissue and its replacement by connective tissue. A similar process is seen in the endometrium, which

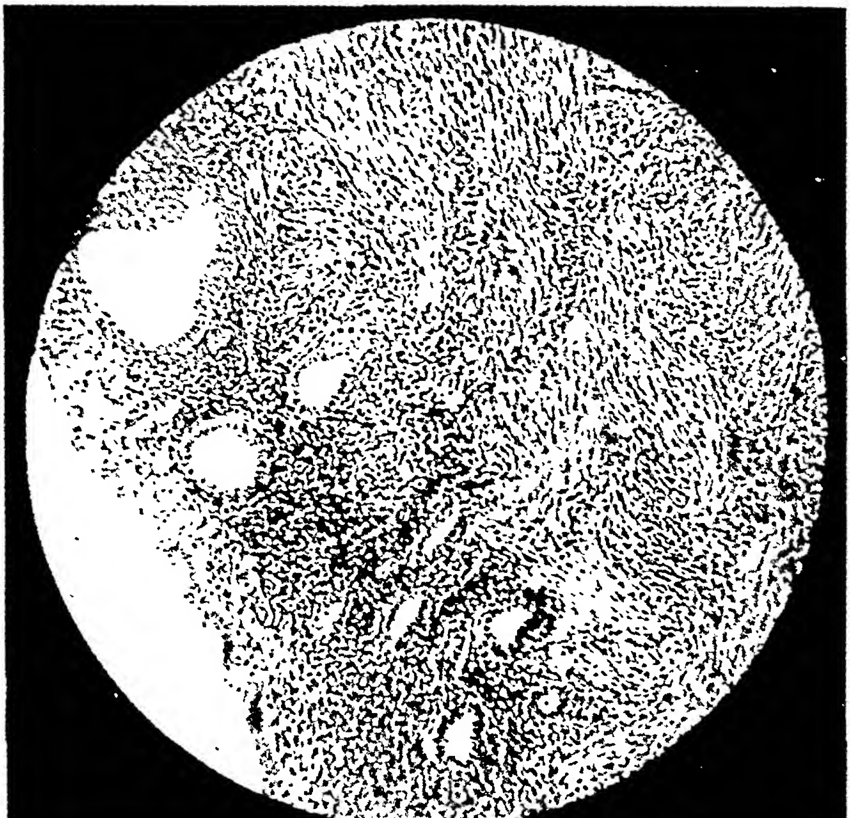

Fig. 118.—Senile endometrium from a patient aged forty-nine years. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

becomes thin and pasty, with low surface epithelium and narrow shrunken nontortuous glands. As a result of interstitial contraction, cystic distention of glands is very common. Similar shrinking of the cervix may result in blockage of the canal, with the production of pyometra when secondary infection occurs.

The *vagina* participates in the retrogressive process, becoming narrow and contracted. In some cases this narrowing is fairly uniform, in others annular contractions may appear at one or more points in the canal, or at the orifice. In rare cases, the blockage of the canal may become complete. The thin atrophic mucosa is prone to ulceration, with frequently the formation of adhesions between opposing surfaces, and the formation of cicatricial bands.

22. Norris: The Menopause; an Analysis of 200 Cases, Amer. Jour. Obst., **61**: 2030, 1910.
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that tissue is invariably lost at the menstrual periods, and that, as a rule, the loss is quite extensive, as will be described below.

The Source of the Menstrual Flow.—The menstrual discharge has its source only in the endometrium, that is, the uterine mucosa above the level of the internal os. The cervical mucosa takes no active part in menstrual bleeding, nor does the mucosa of the tubes. Concerning this latter tissue there was much discussion for many years, but the question is now apparently decided as stated, in spite of the fact, as we shall see, that the tubal epithelium undergoes a definite histologic cycle. It is the endometrium, however, which is most intimately linked with the ovarian function, and it is this tissue alone which exhibits the bleeding reaction, whether normally placed in the uterus, or ectopically distributed, as in cases of pelvic endometriosis.

Structure of the Endometrium.—As the anatomy and histology of the uterus are described in full in another chapter, only a brief reference need be made to the histologic units of the endometrium concerned in the cyclical changes of menstruation.

Epithelium.—The epithelium of the uterine mucosa is commonly described as of the columnar type, but at some stages it is quite low, and of short cuboidal type. While it is commonly spoken of as ciliated, cilia are, as a matter of fact, extremely sparse, and in most uteri they cannot be found at all. This is true not only in fixed and stained preparations, but also when the tissue is examined fresh, by the simple technic of Nylander, which most readily reveals motile cilia when they are present. Just after menstruation the surface epithelium is very low, almost flat, but it steadily increases in height up to the midinterval period, and remains very tall up to the beginning of menstruation. The gland epithelium likewise increases in height up to the midinterval period, beyond which it shows definite and increasing secretory characteristics, with diminution in height. The surface epithelium remains nonsecretory throughout the cycle.

Glands.—The endometrial glands are of the simple tubular variety, with an occasional dichotomous branching of the fundi. Just after menstruation they are very narrow, with very straight lumina, appearing as mere slits on longitudinal section and as small circles or ovals on transverse section. A developmental change at once begins, however, so that the glands become steadily wider and more tortuous, with the high point of development just before the onset of the next period.

Stroma.—This interesting structure bears a superficial histologic resemblance to lymphoid or adenoid tissue, and, indeed, it was so considered for many years by not a few investigators. Leopold,[18] for example, spoke of it as a spread-out lymph gland (lymphdrüsenfläche). It is now, however, looked upon as being a peculiar type of labile, embryonic connective tissue. It is made up of round or slightly oval cells closely packed together, with only a fine supporting meshwork of connective tissue fibrils.

The cells, under ordinary circumstances, are made up almost altogether of nucleus, with an almost imperceptible rim of cytoplasm. They exhibit, however, a marked reactivity to certain physiologic stimuli, particularly that of pregnancy, which brings about marked overgrowth, converting the stroma cells into the well-known decidual cells of pregnancy. The latter exhibit a marked increase in the cytoplasm, which forms a wide mantle around the nuclei.

following menstruation than they are during the actual restoration of the surface at the very end of menstrual bleeding. The postmenstrual stage embraces the period of about one week following the cessation of bleeding. It passes on to the second phase, by an insensible transition, so that the division between the two is of course an arbitrary one.

Interval Phase.—In this, the longest of the four phases, embracing a period of something like two weeks, the hypertrophic changes continue. In the *early interval*, the surface epithelium has become distinctly columnar, the glands wider and moderately tortuous, while the stroma is still quite compact. In the *late interval*, the glands become still wider and more tortuous, the stroma appearing as before. The epithelium, especially that of the surface, is now quite tall, but shows no histologic evidence of secretion. Nor, as a rule, does that of the glands, although toward the end of the interval, appro-

Fig. 120.—Showing the numerous mitoses in both epithelium and stroma during the postmenstrual phase.

priate differential staining methods will reveal the presence of increasing amounts of mucin and glycogen.

Pregravid, Premenstrual, Predecidual or Secretory Phase.—This stage is found for a period of a week or so before the onset of the flow, although, in its frankest form, it is generally best studied only three or four days before the period. The endometrium has now increased markedly in thickness, at times measuring as much as 7 or 8 mm. It is soft and velvety, and usually quite pale, because of the associated edema. The surface epithelium has retained its high columnar form, but that of the glands is now very different from that seen in the earlier stages. It is quite low, and of irregular frayed outline, the cytoplasm apparently melting away into a secretion within the lumen. This, on proper staining, is seen to be rich in mucin and glycogen.

The convolution of the glands is often quite extreme, so that, on longi-

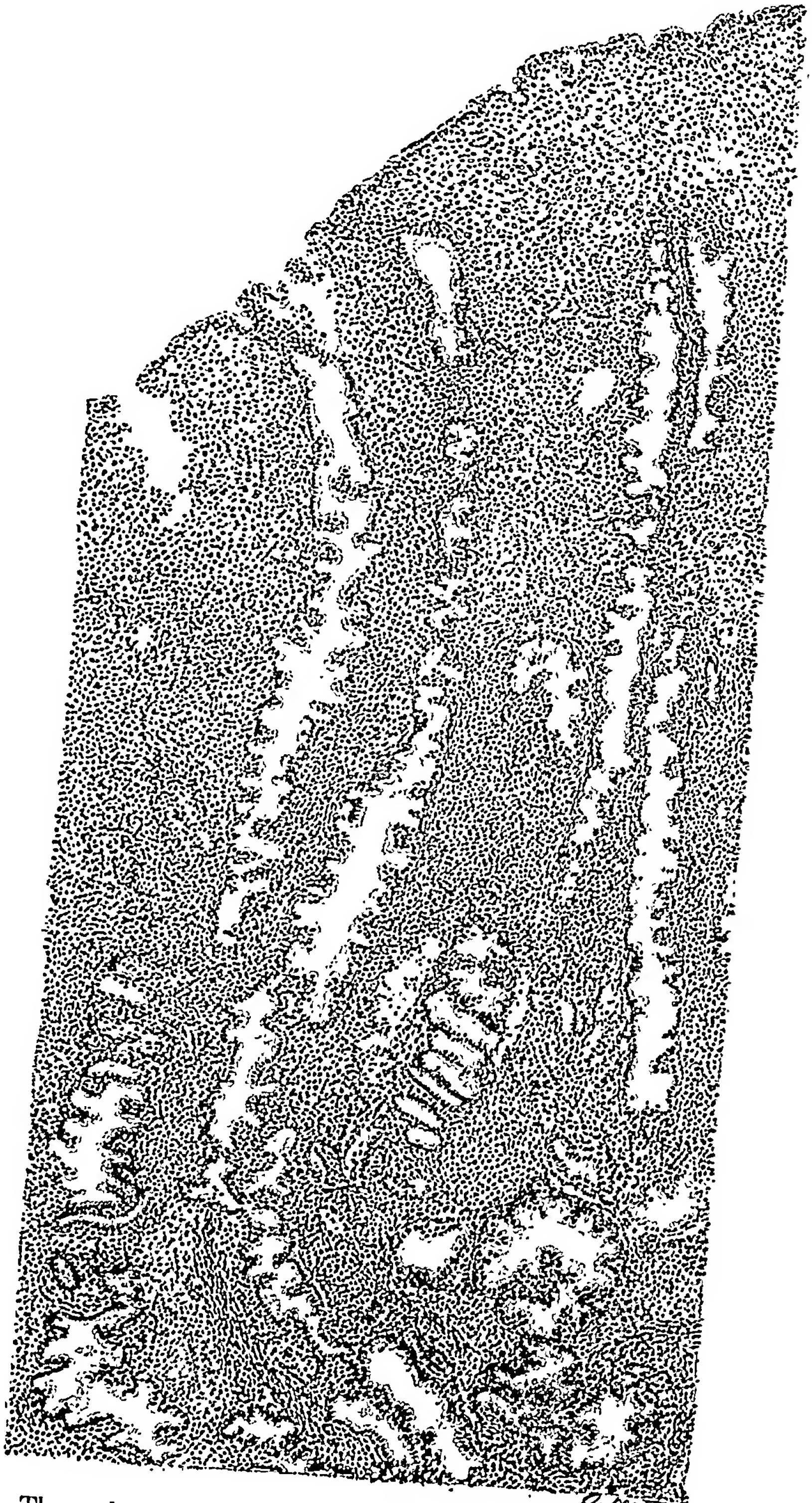

Fig. 122.—The endometrium of the pregravid phase (twenty-fifth day). Note the corkscrew glands, the low, secreting epithelium, and the decidua-like stroma. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

immediately premenstrual infiltrative phase, there is often an impairment of staining in the superficial layers, suggesting, what it probably is, a beginning necrosis preparatory to the menstrual desquamation.

Fig. 124.—Typical pregravid endometrium, showing by contrast the darker staining basalis layer near the muscle. The basalis takes no part in the functional cycle of the endometrium, but is important in the reparative process.

An interesting observation is that the basal layer of the endometrium appears to take no part in the functional histologic changes which have been described. It remains essentially the same throughout the entire cycle.

by a process of shrinkage or involution, without loss of tissue. Schröder's results were not immediately accepted, and certainly in America they were entirely neglected until only a few years ago.

In 1924 Novak and Te Linde[25] published a study corroborating the results of Schröder. The material for this study was collected in such a way as to eliminate errors of technic, which had been responsible for misinterpreta-

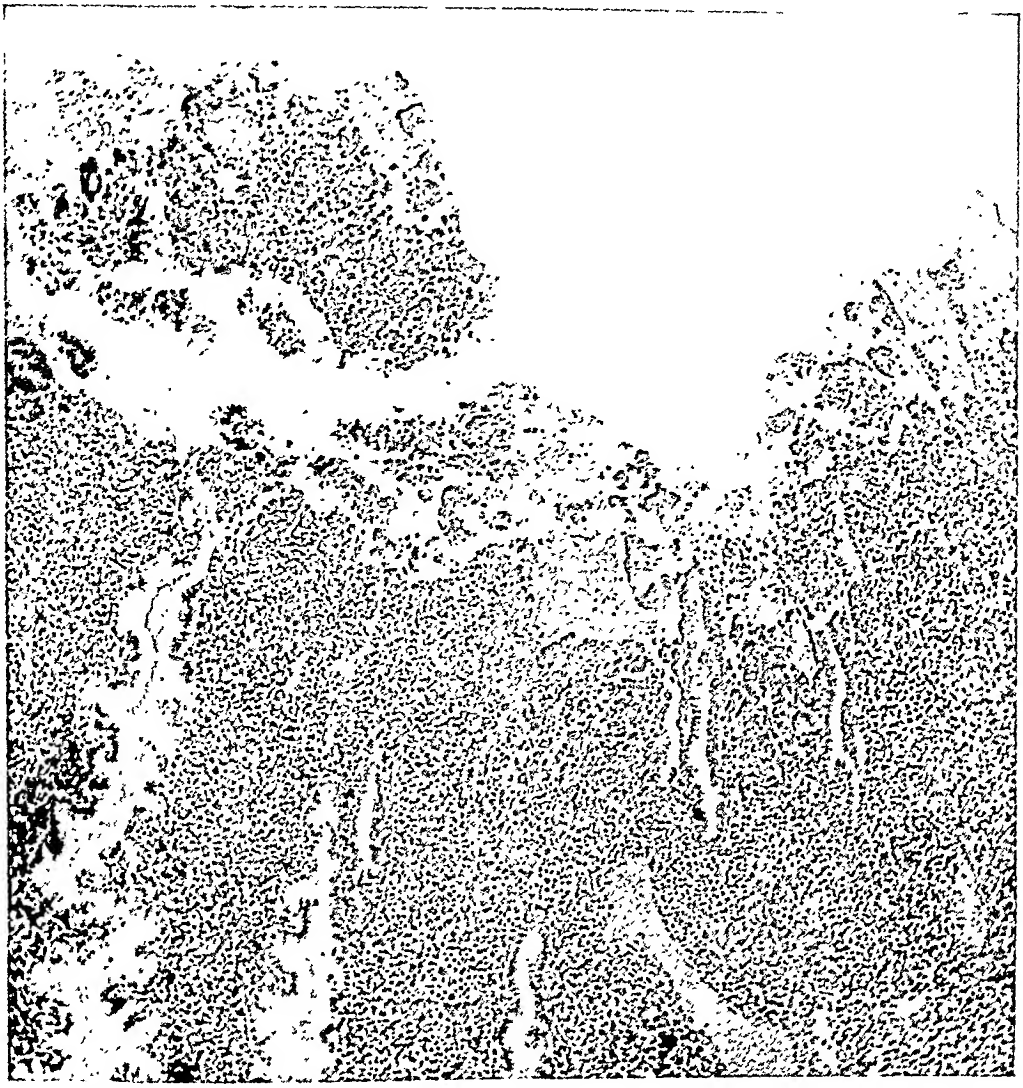

Fig. 126.—Section of another portion of the surface of the endometrium of the uterus shown in Fig. 125, illustrating the crumbling away of the compacta and the cellular infiltration (slightly higher power). (Novak, Nelson, Loose Leaf Living Surg.)

tions in many previous studies. Our investigations showed that tissue loss, usually quite extensive, is the rule with menstruation.

Unless the study is made along chronological lines, however, this tissue loss may be overlooked. For example, the endometrium may show little or no loss on the very first day of the flow, while on the second day, in practically all cases, the entire surface is lost. The desquamated tissue comprises the entire compacta and more or less of the spongiosa, so that

regeneration proceeds from the basal stumps of the glands, which are of course retained. The epithelium of these gland stumps proliferates very rapidly, creeping over the denuded surface, until soon the latter is completely re-epithelialized.

It is of interest to note that, in spite of this rapid epithelial regeneration, mitoses are quite sparse at this stage, suggesting that the cell proliferation may take place, in part at least, by direct or amitotic division of cells. It is not impossible that there may even be, as some have suggested, a meta-

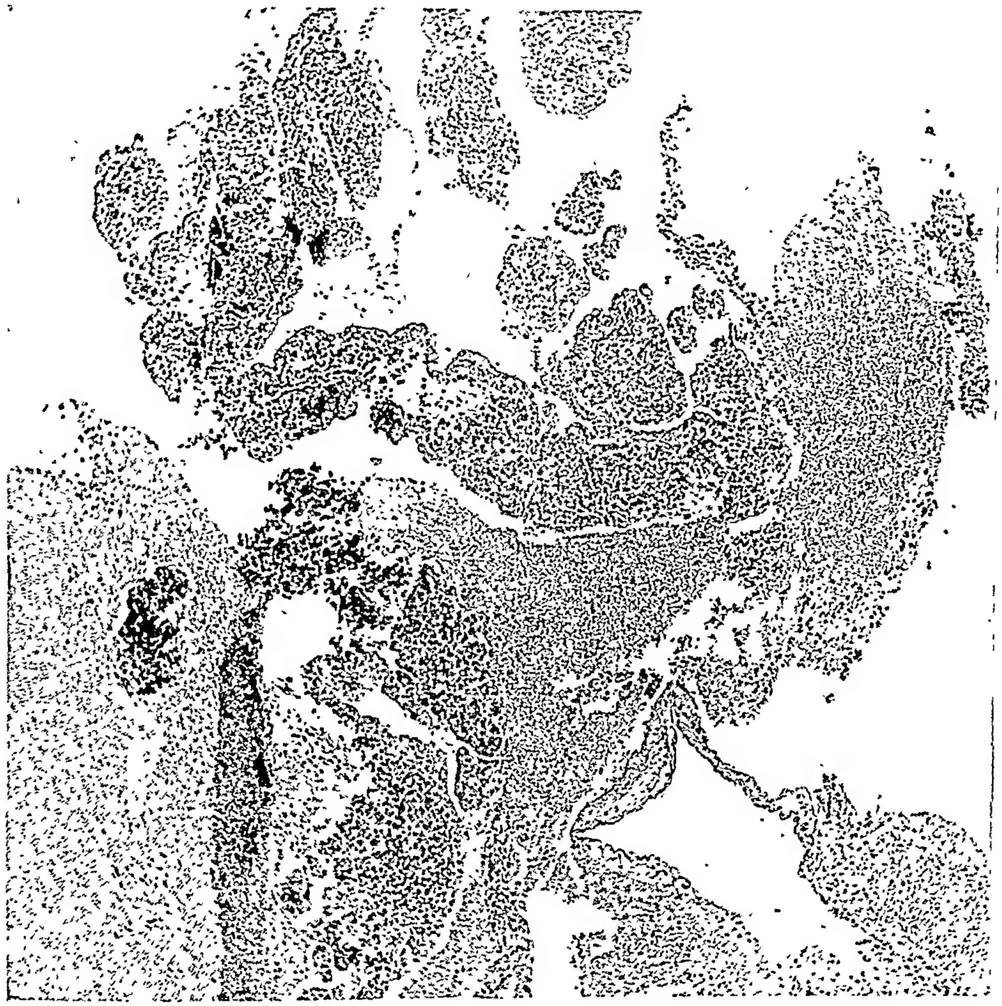

Fig. 128.—Blood clot obtained from cavity of the menstruating uterus whose endometrium is shown in Fig. 127. Cast-off particles of the upper two layers of the endometrium are seen, including not only surface epithelium, but also considerable stroma and numerous glands.

plasia of stroma cells into epithelium. This would be less surprising here than in some other tissues, for both epithelium and stroma are here derived from the mesoderm. There is, however, *no direct evidence on this point.* The regeneration is so rapidly completed that if the endometrium is examined the very day after the cessation of menstrual bleeding the surface is already complete.

Mechanism of Bleeding in Menstruation.—Formerly the menstrual

The tubal epithelium consists of two chief types of cells, the ciliated or nonsecretory and the nonciliated or secretory. The distribution of these cells is uneven, as will be seen in Figure 132. Numerically they appear to be about evenly divided. A third type, the "peg" cells (*Stiftchenzellen*) are also described, but it is probable that these represent only a phase of the secretory cells.

The problem of the cyclical changes exhibited by the tubal epithelium was thoroughly studied by Novak and Everett in 1928.[24] They were able

Fig. 130.—Endometrium on the third day of menstruation, showing practically only the basalis left intact. The epithelization of the surface has already begun, by the outgrowth of epithelium along the surface of the remaining glands.

to demonstrate the following chief characteristics of the tubal epithelium in the four phases into which the menstrual cycle is commonly divided:

1. The postmenstrual phase is characterized first by a low epithelium, which quite rapidly, however, increases in height, so that by the third or fourth day after menstruation it is often almost as tall as during the interval

Fig. 132.—Showing the two chief types of cells in the tubal mucosa. The strip between the x marks is made up of ciliated or nonsecretory cells, while practically all of the remainder in this section are of the nonciliated or secretory type. (Novak and Everett in Amer. Jour. of Obst. and Gyn., October, 1928.)

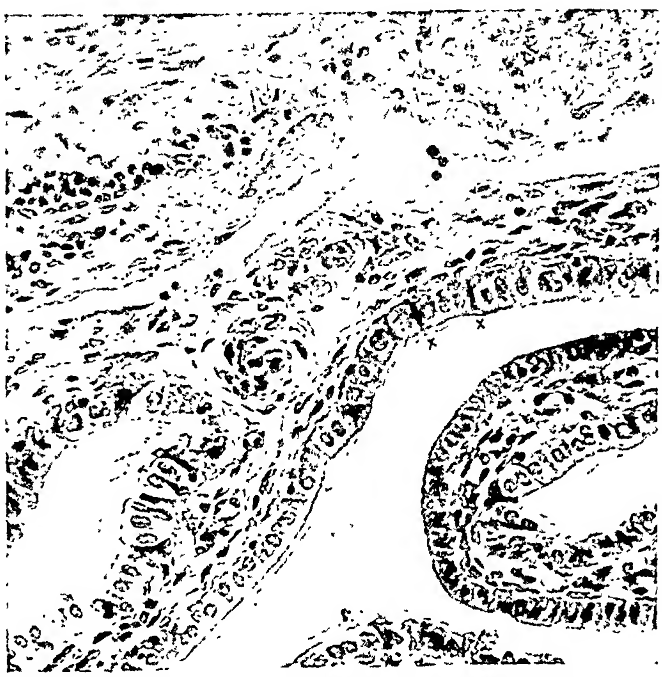

Fig. 133.—Tubal epithelium at end of menstruation. The cells are low, the ciliated variety being still quite wide, and the nonciliated having given off their secretion, leaving only the nuclei. Most of the cells in the strip to the left are clearly ciliated, those on the right nonciliated. Note the dark rodlike "peg" cells at x. (Novak and Everett in Amer. Jour. of Obst. and Gyn., October, 1928.)

Fig. 136.—Premenstrual tube, showing (x) the peculiar extrusion of nuclei, which is seen also in many of the lower animals. At y is seen a collection of such extruded nuclei lying free in the lumen. (Novak and Everett in Amer. Jour. of Obst. and Gyn., October, 1928.)

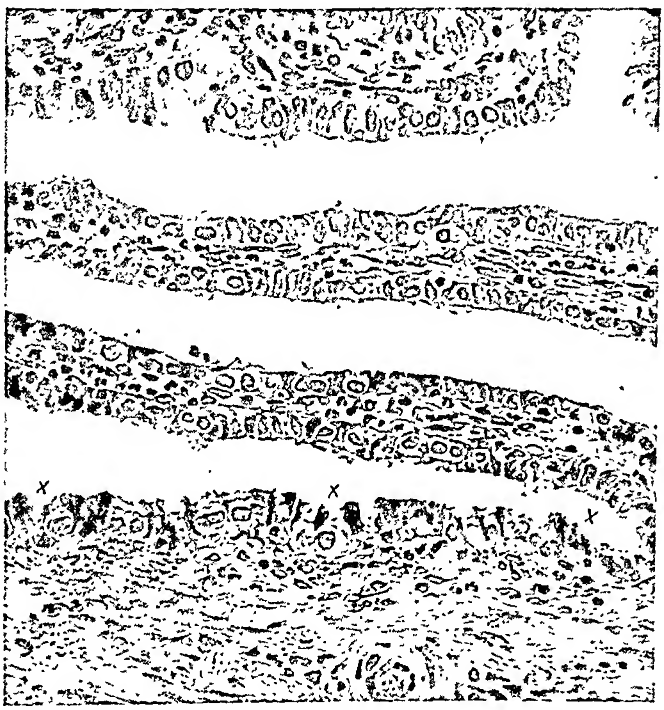

Fig. 137.—Tubal epithelium during menstruation (twenty-four hours after onset). The row of cells indicated at x shows persistence of premenstrual picture, while in other parts of the lumen the cells have assumed the more typical postmenstrual type, *i. e.*, low and without secretion. (Novak and Everett in Amer. Jour. of Obst. and Gyn., October, 1928.)

the lower animals, a definite histologic cycle of the vaginal mucosa has been demonstrated, there is as yet no agreement as to whether a corresponding cycle occurs in the human vagina. In the case of the rat, Stockard and Papanicalaou demonstrated a vaginal histologic cycle as far back as 1917, and, indeed, the universally employed vaginal smear method for the chronological study of the cyclical phases in experimental animals is based upon this demonstration.

In 1927,[5] and again in 1930,[6] Diercks reported studies upon the human vagina from this standpoint, concluding that a definite cycle occurs. He divides the vaginal epithelium into three layers, viz., functional, basal, and an intra-epithelial horny layer. With the advance of the cycle the mucosa is thickened, and a definite intra-epithelial hornified layer appears. With the onset of menstruation the superficial or functional layer is thrown off, at least in part. Lindeman also described three similar layers, but did not consider them of cyclical significance, finding similar pictures with amenorrhea, during pregnancy or the puerperium, and after the menopause. Somewhat similar conclusions were reached by Pankow (1928), while Geist,[8] in a very recent study, concludes that the "vaginal mucosa undergoes a cyclical variation that keeps pace in a general way with the cycle in the ovary and uterus," although he states that it is difficult to accord to each picture its proper place in the cycle.

Finally, attention may be called to the most recent study of the problem, that of Stieve (1931),[32] in which a very discordant note is sounded. This author emphasizes that pictures exactly similar to those described by Diercks can be found in such tubular canals as the male esophagus, especially in its narrower portions, where irritation is most likely. He therefore attaches no cyclical significance to the changes described by Diercks, emphasizing only a premenstrual thickening of the mucosa, with increased vascularity and edema. He stresses the fact that different histologic pictures are encountered in different parts of the vagina at the same time, an observation with which my own experience agrees.

All in all therefore, it will be seen that, while in some of the lower animals a vaginal histologic cycle has been definitely established, and while there is some evidence that a less clearly marked cycle occurs in the vaginal mucosa of women, there is still much confusion as to its constancy and its characteristics.

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8. Geist: Cyclical Changes in Vaginal Mucous Membrane, Surg., Gyn., and Obst., 51: 848, 1930.

CHAPTER VIII

CYCLICAL CHANGES IN THE OVARY

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Introduction.—The menstrual cycle in the endometrium, already described, is paralleled by a cycle of histologic events in the ovary. The uterine changes, indeed, are the direct result of those occurring in the ovary. The two sets of phenomena must therefore be studied together, and with proper regard for their chronological relationships. In no other way can one acquire an intelligent concept of the anatomical mechanism of menstruation.

The anatomy and histology of the ovary have been fully discussed in another chapter. As regards menstruation we are chiefly concerned with the follicular apparatus, *i. e.*, with the graafian follicles and their derivatives, the corpora lutea. The possibility of some participation of the stromal cells in the process cannot be excluded, but is unsupported by any worth-while evidence, so that it need not be discussed. The so-called "interstitial cells," found in considerable numbers in the ovaries of many lower animals, are not, according to most observers, found in the human ovary. Their analogues, in the human, are believed to be the so-called "theca-lutein cells" of the atretic follicles during pregnancy. They have no known connection with the reproductive cycle, but their significance will be touched upon in a later paragraph.

HISTOLOGIC CHANGES IN OVARY

Graafian Follicle.—The *primordial follicles*, found in such large numbers in the ovaries of all women from the time of birth to the cessation of the menstrual function, possess a very simple structure. They are tiny spaces almost filled by the oocytes, and enclosed by a single layer of epithelial cells, at first almost flat, but later becoming cuboidal. After each menstrual period, supposedly as a result of the removal of corpus luteum inhibition, many follicles begin to develop. For some unknown reason, one of these, destined to become the "presiding follicle" of that particular cycle, outstrips the rest, and the remaining follicles are blighted at various stages, through the degenerative process spoken of as *atresia folliculi*.

The earlier stages of development of the follicle are characterized by a proliferation and stratification of the follicular epithelium, or granulosa, and this process advances so that in the mature follicle the granulosa may be many layers thick, its cells showing rather numerous mitoses. The cavity of the follicle becomes larger and larger because of the accumulation of the follicular fluid, or *liquor folliculi*, while the ovum becomes embedded in a projecting peninsula of granulosa cells spoken of as the *cumulus oophorus* or *discus proligerus*. The cells of the innermost layer, *i. e.*, the layer closest to the ovum, are arranged in a radiating fashion, constituting the *corona radiata*, which in turn is superimposed on an acellular hyalized *zona pellucida*. Within this is the *ovum*, in its *perivitelline space*.

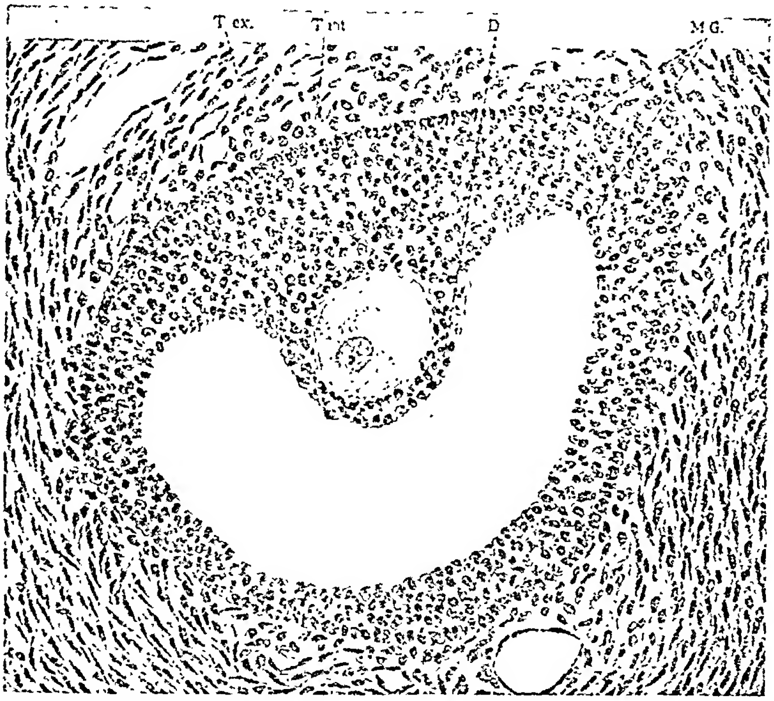

Fig. 141.—Follicle approaching maturity. *D.*, Discus proligerus; *M.G.*, membrana granulosa; *T.ex.*, tunica externa; *T.int.*, tunica interna. (Williams.)

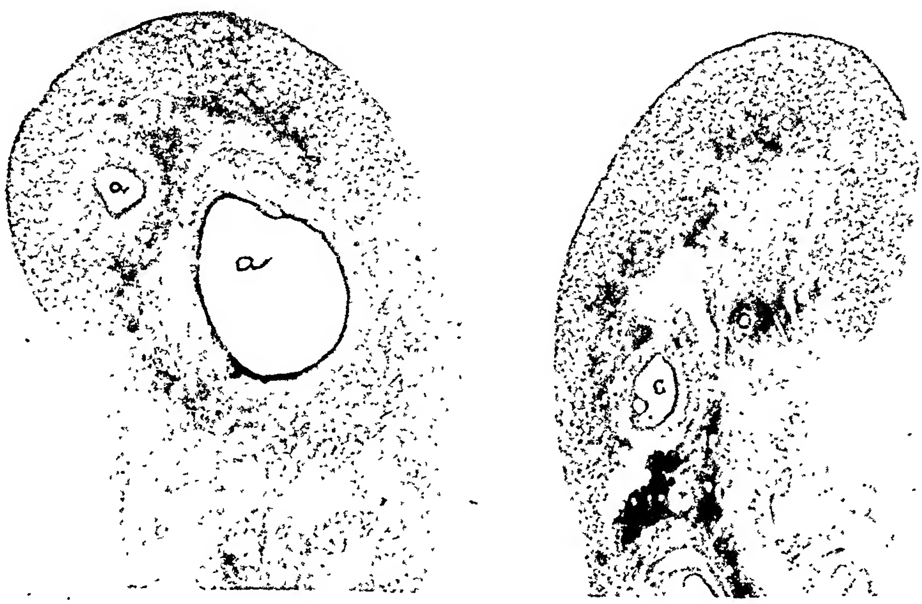

Fig. 142.—Atretic follicles (*a*) in ovary of infant two days old. A maturing follicle is also seen (*g*), while the ovarian stroma is studded with innumerable primordial follicles. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

These features of follicular maturation are well shown in Fig. 141. It will be noted that the granulosal layer, even in the well-developed follicle,

maturity, which start out abreast of it in the earlier stages of maturation? As already stated, their development is checked at various stages, with death of the ovum, and consequent death of the satellite epithelium of the follicle. Physiologically the ovum is the dominant follicular constituent, and its death means the death of the follicle. The blighted follicle remains as an atretic follicle, or, clinically, a follicular cyst. These *atretic follicles* may be very small or, through pathologic accumulation of the follicular fluid, may become large enough to assume clinical importance. They may show a lining of persisting granulosal cells, either as a single layer, or stratified, and, if single, often flattened out. In later stages the epithelium disappears, so that the cyst is lined by the fibrous cells of the theca interna. Numerous small cysts of this type are found in almost every ovary. When present in excessive number they produce the picture so often spoken of as "cystic degeneration" of the ovary, to which so much pathologic significance was at one time ascribed.

The later history of the atretic follicle is one of advancing shrinkage and ultimate obliteration through the deposit of new connective tissue elements from the theca, so that in its final stages it appears as a small shrunken clump of cicatricial tissue, the so-called *corpus fibrosum.*

THE CORPUS LUTEUM OF MENSTRUATION (CORPUS LUTEUM SPURIUM)

The life cycle of the corpus luteum begins with the discharge of the ovum from the follicle. The mechanism of ovulation itself will be discussed in a later paragraph. The older view was that after ovulation, the shell of the follicle is filled with blood, that this gradually undergoes organization and cicatrization, that a peculiar yellowish pigment is deposited in the wall of the structure, and that the corpus luteum has no further function in the cycle. The studies of Fraenkel,[11] in 1903, followed by those of Schröder, Meyer and others, have clearly demonstrated that the corpus luteum, beginning its life history at the time of ovulation, passes through a cycle of changes as clearly marked and as definitely correlated with the endometrial changes as those seen in the follicle, and that its function in the cycle is no less important than that of the latter. These cyclical changes may conveniently be divided into four phases, as suggested by Meyer.[19]

1. Stage of Hyperemia or Proliferation.—The changes characterizing this phase are a continuance of the proliferative and other processes beginning before rupture of the follicle. The discharge of the ovum, and with it of adhering cells of the discus proligerus, leaves behind the shell of the follicle, lined by the granulosa. The point of follicular rupture, or *stigma*, is rarely observed clinically, for it is quickly covered over by a fibrinous plug which soon shows organization changes. Contrary to the older view there is as a rule little or no bleeding associated with the rupture of the follicle.

The discharge of the ovum and of the liquor folliculi is at once followed by a crumpling of the follicle, so that its wall becomes undulating in outline. In its earliest stages the corpus luteum is anything but a conspicuous structure, appearing as a flattened, scalloped vesicle at or near the surface of the ovary. The stigma is histologically readily recognizable in appropriate sections. The lining of the cavity is not bright yellow, as in the mature corpus, but is of grayish-yellow hue. Most frequently these earliest stages of the corpus

blood vessels pushing into it from the theca and extending to the inner margin of the granulosa. This process is apparently responsible for the fact that *bleeding into the* lumen is now noted. Usually the blood is zonal in its distribution, forming a layer of varying thickness along the inner granulosal margin. At times, however, the bleeding is so abundant that the cavity is inundated, and it may be so distended with blood as to constitute a large hematoma (*corpus luteum hematoma*).

The other striking feature of this stage is the definite *luteinization of the granulosa cells*, which gradually become more and more polyhedral and vacuolated, so that their lutein character is unquestioned. The thin strands of fibrous tissue from the theca, with their accompanying blood vessels, give the lutein zone an irregularly trabeculated appearance.

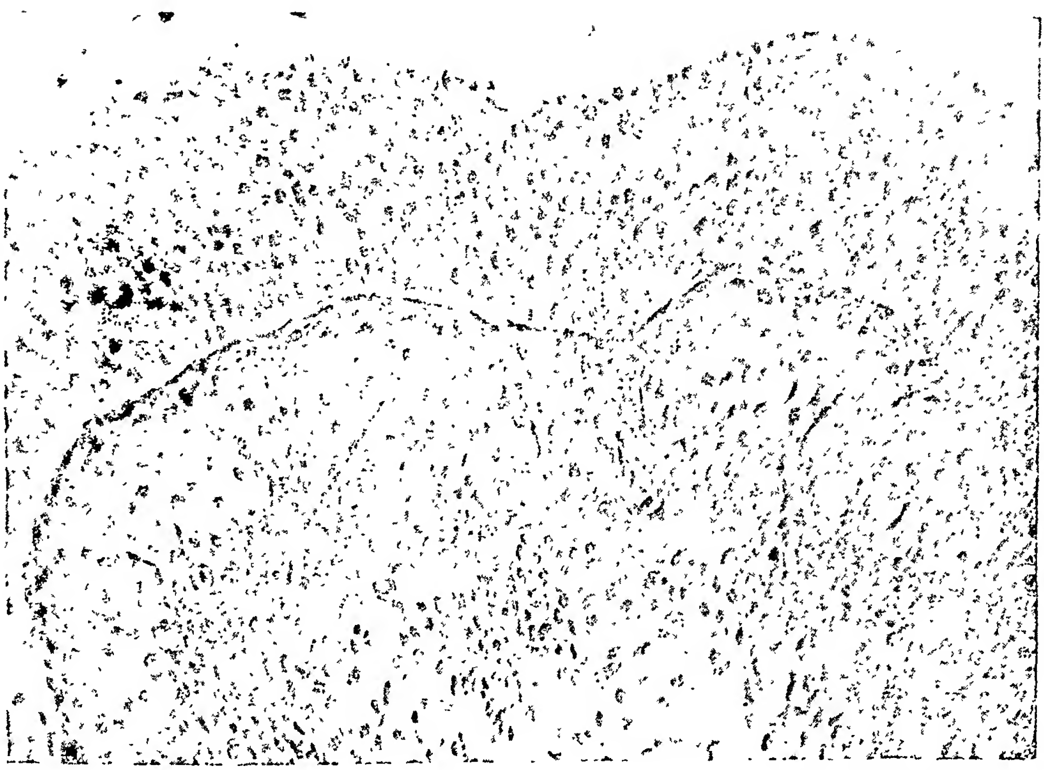

Fig. 145.—High power picture of corpus luteum shown in Fig. 144. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

The theca interna cells, which up to this time have been large and polyhedral, shrink up and assume more the appearance of ordinary connective tissue. This is believed to be due to the giving up of lipoid substances which, before the development of blood vessels in the granulosa, furnish nutriment to the latter.

During this phase the corpus luteum (*corpus luteum hemorrhagicum*) is usually recognizable on the *surface of the ovary*. On cut section the blood within the lumen, and the rather thin, moderately undulating wall, with its now bright yellowish color, are the chief characteristics. It varies in size, being sometimes less than 1 cm., though it may be as much as 2 cm., especially when hemorrhage into the lumen has been abundant. The patho-

margin of the lutein cells, a delicate layer of organizing connective tissue is now evident, shutting off the lutein zone from the lumen and suggesting its now obviously endocrine structure and function. Trabeculae of the theca, carrying blood vessels, dip deep into the theca, so that the secretion of the lutein cells finds ready access to the blood stream.

A striking but not constant feature is the transformation of the theca cells, especially those of the septa, into small, polygonal cells, which are arranged in a trabeculated fashion, so that they resemble the lutein tissue itself, except that the cells are smaller and more closely packed. The signifi-

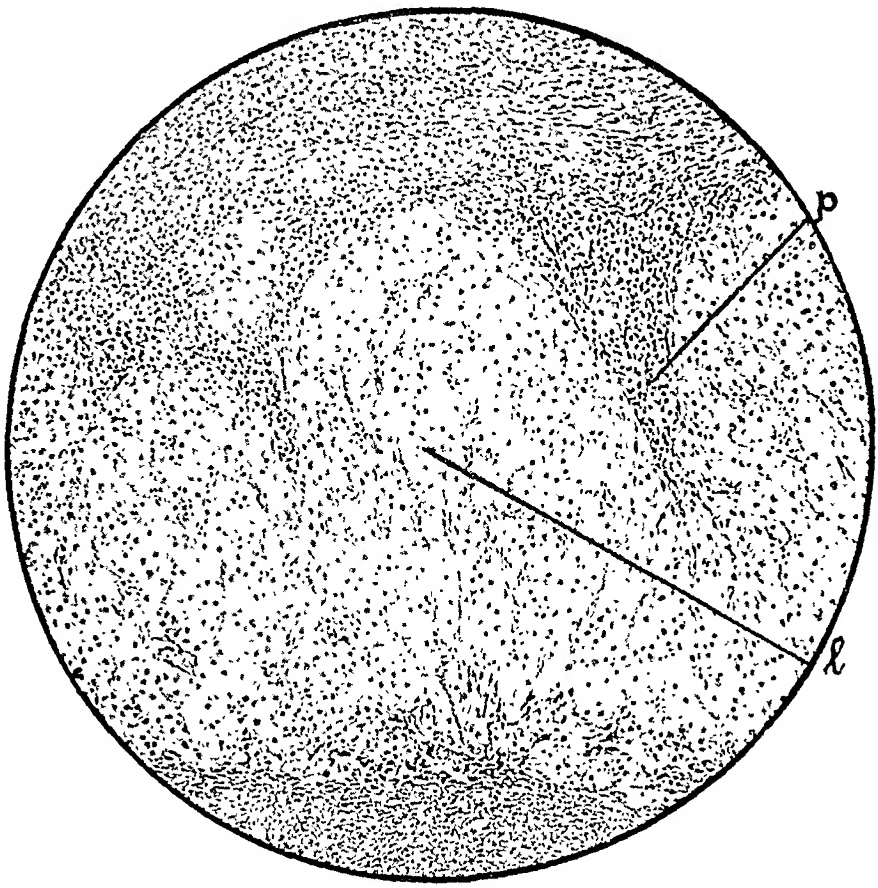

Fig. 147.—Wall of mature corpus luteum, twenty-seventh day (low power), showing lutein (*l*) and paralutein (*p*) cells. The latter are found in the wedgelike septa. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

cance of these *paralutein* cells is not clear, though there can be little doubt that they possess an internal secretory function of some sort. Their presence, however, furnishes additional proof, if any were needed, that the lutein cells must be of granulosal origin. If an origin from the theca interna were assumed, the paralutein cells would obviously be derived from the theca externa, a tissue to which no one has ascribed any rôle in the formation of the corpus luteum.

The stage of maturity is reached five or six days before the onset of the menstrual period, with its acme just before the onset of the bleeding. The

Fig. 149.—Large mature corpus luteum near surface of ovary.

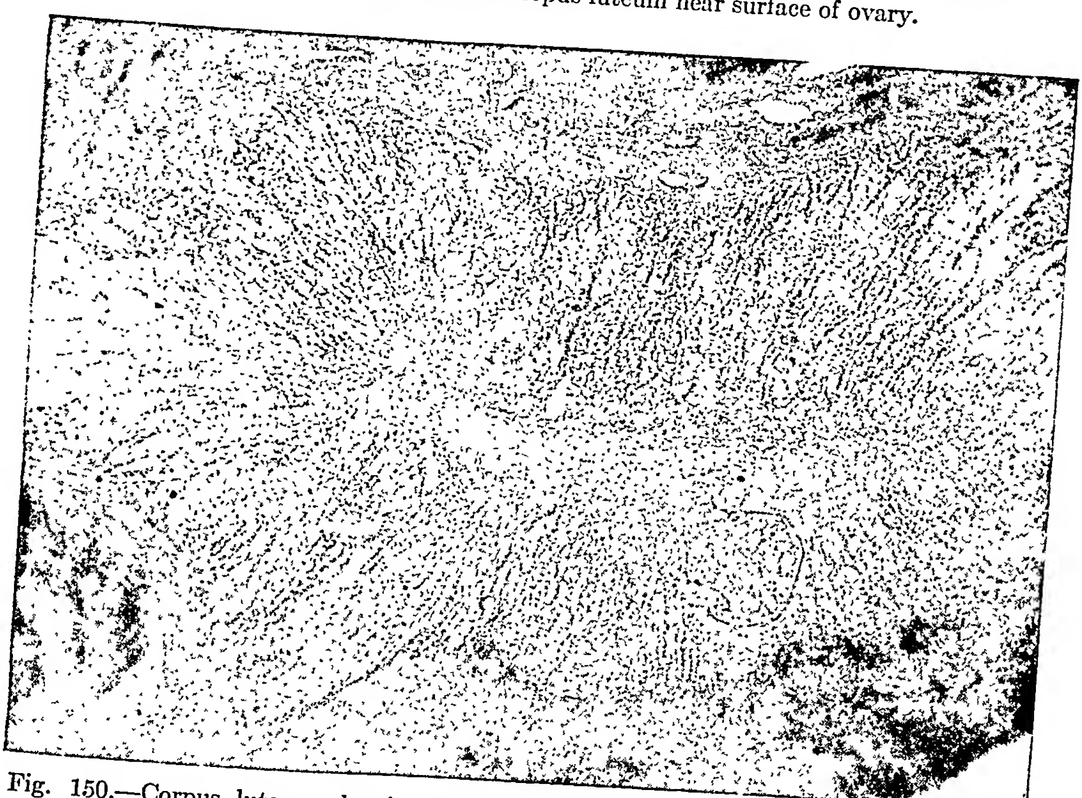

Fig. 150.—Corpus luteum showing beginning of retrogression (low power). (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

The rapidity of retrogression apparently varies, so that some ovaries show only one retrogressive corpus, while others may show several. Generally, however, there is little trace of the structure after three months.

THE CORPUS LUTEUM OF PREGNANCY (CORPUS LUTEUM VERUM)

If fertilization supervenes menstruation does not occur, and the corpus luteum, instead of retrogressing, exhibits an advance in development beyond that described for the mature corpus luteum of menstruation. The structure continues to increase in size, so that it is usually easily distinguishable on the ovarian surface. The lutein zone is broad and there is a heavier deposit

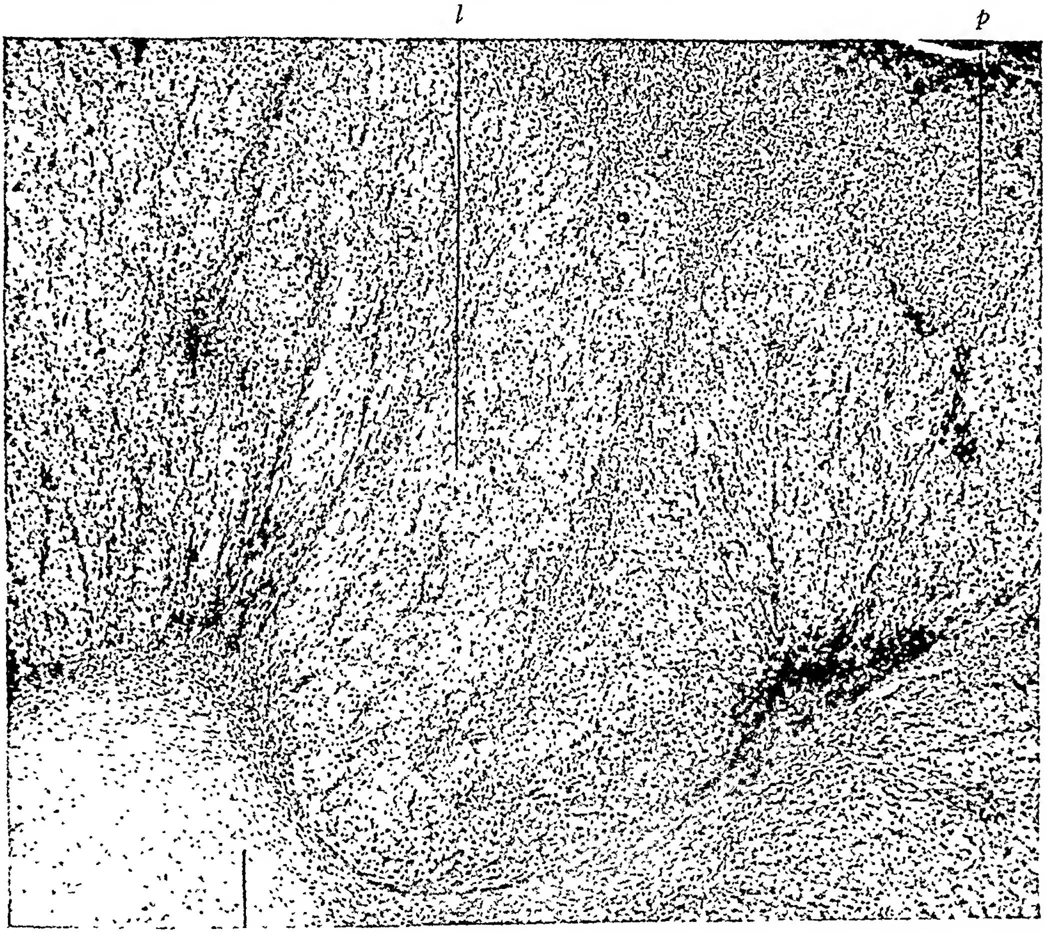

Fig. 152.—Corpus luteum in a case of early pregnancy (low power), showing lutein cells (*l*), paralutein cells (*p*), and organization of contents (c). (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

of fibrous tissue along its inner margin, especially in the angles between the lutein undulations. Not infrequently the cavity is quite cystic, the contained fluid being a light straw in color. In other cases the corpus shows much less fluid and much more connective tissue. As in the case of the corpus luteum spurium, paralutein cells are often, though not invariably, well marked.

The true corpus luteum remains as an active functioning structure until about the fourth month of pregnancy, when a slow retrogression sets in, although traces of the structure are often evident as late as the seventh month.

Interstitial Cells of the Ovary.—In former years there was much discussion as to the so-called "interstitial cells of the ovary," the interest in these elements having no doubt been engendered by the accepted importance of the interstitial cells of the testis (cells of Leydig). The ovaries of many of the lower animals, especially the rodents, exhibit such interstitial cells scattered throughout the stroma, but under normal conditions no such elements are found in the human ovary.

It is only in the ovary of pregnancy that we can speak of interstitial cells, or of an interstitial gland, in any way analogous to corresponding elements in the male gonad. During pregnancy, especially in its later phases, the theca cells of the atretic follicles, so numerous during gestation, often exhibit a striking transformation into lutein-like cells. It is these theca-lutein cells of the ovary of pregnancy which are commonly looked upon as the analogues, and apparently the only analogues, of the cells of Leydig in the testis. The evidence for this is by no means complete.

These theca-lutein cells often show marked proliferation, forming large masses which invade the ovarian stroma, and constituting the so-called "interstitial glands of the ovary." The cells themselves, in the cases which I have had an opportunity to study, resemble the paralutein cells of the corpus luteum (*vide supra*) much more than they do the lutein cells themselves. Certainly their appearance and arrangement suggest a probable endocrine function, but just what it is cannot be stated as yet. An excellent review of the entire question of the "interstitial cells" has been published recently (1930) by Josef Novak,[26] of Vienna. This author concludes that the ovaries of all mammals contain "interstitial cells," using the term in the broad sense as representing the stromal cells. The theca-lutein cells, to which many restrict the term, are to be looked upon as derivatives of the connective tissue, and are found most characteristically in early childhood, in pregnancy, and with hydatidiform mole or chorio-epithelioma. That they play an endocrine rôle of some sort is undoubted, although its precise nature can only be conjectured.

Macroscopical Changes in the Ovary.—These cannot, in general, be considered very conspicuous. Beginning, as in the case of the endometrium, with the phase *immediately following menstruation*, the most striking feature in the ovary is the *corpus luteum, now in the stage of retrogression.* It may be detectable on the surface of the ovary as a slightly raised moundlike elevation through which the dull yellow color of the corpus may be visible. Perhaps even more frequently the retrogressing structure is disclosed only on section into the ovary, though commonly quite near its surface. During this stage, as we shall see, *maturation of the follicles also begins*, though it is not possible to pick out such follicles in this stage from the atretic follicles studding most ovaries.

Toward the *middle of the intermenstrual period*, or even earlier, one of these *growing follicles* reaches full maturation and is ready for the *discharge of the ovum.* This stage, however, is rarely discernible with precision in the human ovary, for here again it is difficult to distinguish between the mature viable follicle and the atretic follicles which are so often present on the surface of the ovary. The problem is of course much easier in the case of most of the lower animals.

Occasionally one may observe flattened, collapsed follicles on the ovary,

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discharge from the follicle retains its vitality for a definite span, averaging probably about fourteen days. Its death is the signal for the collapse of the structure thus far ministered over by it.

There is much to be said in favor of the ovum as the center of activity. This is certainly true of the ovum in the follicle, for death of the ovum means cessation of follicle development. *It is true of pregnancy*, for from the trophoblast of the egg, perhaps from the embryo also, emanate chemical messengers which bring about the well-known pregnancy changes in the female organism. On the other hand, that the small ovum, wandering through fallopian tube and uterus, should be expected to emit hormones sufficient to affect the cycle seems rather far-fetched. The matter has, however, been set at rest by the experiments of Allen, Pratt, Newell and Bland, who showed that in the human, in consonance with numerous findings in other mammals, the ovum lives but a short time after its discharge from the follicle. Furthermore, the removal of such an egg or eggs from the tube does not change the rhythm of the cycle in the least.

That the ovum as it exists in the ovary is not as important as we had in the past supposed is suggested by the experiments of Parkes (1926), who found sexual cycles persisting in rats all of whose ova had been destroyed by *x*-ray. In due time after the irradiation the germinal epithelium is found to proliferate corpus luteum-like cells in two waves. These are perhaps the cells responsible for the cycles. We have seen Parkes' preparations and found no vestiges of ova. The interpretation of the authors is reasonable, especially since it must be remembered that both ova and their satellites, *the granulosa cells, arise from the germinal epithelium, as do the regenerative* waves described by the British authors. Perhaps the *x*-ray merely prevents the differentiation of the cells into ova.

The above, in skeleton outline, represents the point of view of gynecologists as to the actual sequence of events in the menstrual cycle. No criticism can be made of the picture even now in so far as it represents the normal human cycle. On the other hand, the cold fact remains that absolute proof is lacking that the death of the egg, degeneration of the corpus luteum and menstrual bleeding and desquamation are causally related. While a definite answer is not yet possible to the question of the real cause of menstruation, it is the object of this chapter to present some of the new data recently published, since these point the way to methods of further study.

MENSTRUATION WITHOUT OVULATION

Up to quite recently the question as to whether menstruation can occur without ovulation would have been answered unhesitatingly in the negative by most students of the problem. Indeed, ovulation was the starting point of the whole current theory of menstruation. Even now, as indicated above, there can be little doubt that in women ovulation usually occurs in each cycle and hence is a characteristic precursor of menstruation. The investigations of Corner, Allen and Hartman on the sex cycle of menstruating monkeys, corroborating the older, less well-controlled observations of Heape and of van Herwerden, make one wonder whether ovulation is as indispensable as we have hitherto believed. All of these have described many instances of regularly recurring menstruation where examination of the ovaries, even by serial sections, demonstrated the entire absence of visible graafian follicles,

monkeys. In the clinical cases ovulation does not occur, for corpora lutea are characteristically absent, but there is a persistence of the unruptured graafian follicles. Such phenomena are doubtless the expression of the endocrine imbalance of adolescence which is correlated with a relative sterility of this period (Hartman, 1931). Young monkeys, like young girls, exhibit these irregularities and abnormalities also (Hartman, 1932), though no case of hyperplasia such as is found in women in connection with persistent ovarian follicles has ever been seen in the monkey.

Before proceeding further in our search for the underlying causes of menstruation let us concede for the moment that ovulation and corpus luteum formation are not essential. Since it is well known that removal of all ovarian tissue abolishes the female cycle, it follows that either the graafian follicle, or the stromal tissue of the ovary, warrants consideration, and certain facts point to the anterior lobe of the pituitary as playing an important directing rôle in the events that culminate in the menstrual flow.

RELATION OF ANTERIOR PITUITARY TO SEX CYCLE

It has been known for many years that some such relation must exist between the anterior pituitary and the gonad, but the experimental basis for this belief was not great. It consisted chiefly of a study of ablation effects and of the effects produced on the genital system by pituitary lesions, more particularly tumors. These studies, however, pertained chiefly to conditions of pituitary deficiency, while, aside from an occasional report, such as that of Cushing and Davidoff on the ovaries in a case of acromegaly, there has been little knowledge of the ovarian changes produced by hyperactivity of the anterior lobe.

The remarkable results obtained by Evans and Long by the injection of properly prepared extracts of the anterior lobe may perhaps be taken as the starting point of our newer knowledge of this subject. These investigators, by the intraperitoneal injection of extracts of beef pituitary, were able to produce not only an experimental gigantism but also striking effects on the ovaries. These consisted chiefly of an inhibition of ovulation and a stimulation of the luteal tissues of the ovaries, so that many corpora lutea were produced, often showing within them the imprisoned ova (pseudocorpora lutea). These changes are stressed because they are quite different from those observed in the classic studies of Smith, with Engle as a later co-worker, and Zondek and Aschheim. The work of these American and German investigators, published almost simultaneously and quite independently, represents one of the most brilliant advances in our knowledge of sex physiology.

Smith conceived the idea of studying the problem by the method of repeated transplantation, as a more reliable means of establishing the functions of the gland than the administration or injection of extracts, or even than single transplantation. For details of the technic employed, the reader is referred to the complete paper of Smith and Engle. If a series of daily transplants are thus made into an immature female mouse or rat, even one at the weaning age, remarkable effects on the uterus, vagina and ovary are noted, usually in three days. The uterus is hyperemic and distended, and the ovaries are so enormously enlarged that their combined weights are from eight to fourteen times that of the untreated, normally maturing

is produced, and all oestrous phenomena are absent. This indicates that the pituitary produces its effect only through the agency of the ovary. In the words of Zondek and Aschheim, the anterior lobe is the "motor of the ovary."

That the effect of this "motor" is concerned with a more or less evanescent maturation of the sex organs, of local and not general somatic effect, was shown by Engle (1931). The experimental animals in whom sexual "maturity" was induced by anterior lobe transplants came into their first spontaneous oestrus not earlier but later than their controls. It follows, therefore, that the anterior lobe hormone is ovary-stimulating in its effect but not a true "maturity" hormone.

The significance of these investigations as applied to the menstruation problem is readily apparent; hence the detail with which this section has been presented. Since the ovary is normally necessary for the continuance of the menstrual cycle, is it the prime factor? Can menstruation be produced by some other factor in the complete absence of the ovary? These questions will be discussed below.

THE DUALITY OF THE OVARIAN SECRETION

In the pioneer work of Bouin and Ancel (1910, 1911) and of Loeb (1911) it was shown that the sexual cycle, where long enough for pseudopregnancy changes to take place, could be rather clearly divided into a follicular and a luteal phase. In the rabbit, both the uterus and the mammary gland offer appropriate test organs. The same phases have also been recognized in the human since Hitschmann and Adler's important studies of the menstrual histology of the endometrium (1908), and the correlation of this with the ovarian histologic cycle. These studies were all histologic. The experimental work began with Fellner, Iscovesco, and Hermann, who laid the foundation for the rapid strides of the last decade. (See Frank's "The Female Sex Hormone," 1929; also E. Novak, 1930, and W. P. Graves, 1931.)

A contribution of prime importance was the demonstration of the potency of the liquor folliculi in inducing oestrous changes in castrated animals. The credit for the initial work in this field belongs to a group of American investigators, particularly Frank and his co-workers, and Allen, Doisy and their collaborators. With the discovery of the potency of the follicle principle, there became evident a disposition on the part of a good many students of the subject, including those just mentioned, to attribute to the follicle hormone the all-important and perhaps the only rôle in the induction of the sex cycle, even including the human cycle. This tendency was criticized by Novak in a paper published in 1927, chiefly on the ground of the differences in the sex cycles of the lower animals as compared to the human being from histologic, chronological and physiologic standpoints. One conclusion reached in this paper was that "in such animals as the rat the evidence clearly indicates that the cycle is dominated by the follicle and that the corpus luteum does not become important until after impregnation. In the human, on the other hand, the follicle is of importance in the menstrual cycle, but so is the corpus luteum, which is well developed in the nonpregnant woman."

The weakness in the position of the advocates of the dual secretion theory lay in the fact that the characteristics and the potency of the follicle hormone had been definitely established, while the existence of an active corpus

Meyer and Fevold were able to secure a good beginning of the secretory phase of the uterine glands.

For the second series of experiments Corner and Allen (1928) first satisfied themselves of the truth of Fraenkel's contention that if the ovaries or the corpora lutea in the rabbit are removed in the early stage of pregnancy the fertilized ova invariably die. If, however, progestin is injected from the time of the operation, the substitution therapy is entirely successful and the embryos can be carried even to term. The authors define a rabbit unit of corpus luteum extract as the minimum dose that suffices, when divided into five daily doses, to alter the uterus of a doe weighing from 3 to 4 Kg., under the specified experimental test, to a state similar to that of the uterus at the eighth day of normal pregnancy.

It is hardly necessary to state that in their experiments the proper controls were made with the follicular hormone. This is as ineffective in producing progestational proliferation as it is in the production of placentomata (Loeb and Kountz, 1928). Nevertheless, as Hisaw and Leonard (April, 1930) and W. M. Allen (April, 1930) discovered independently, the uterus must first be brought into a state corresponding to oestrus before progestin will act. This is the "one-two reaction" of Hisaw. The division of the endometrial changes into the follicular and the luteal phases is, therefore, eminently justified. It may be mentioned, parenthetically, that a preliminary preparation of the mammary gland by folliculin seems also to be essential for the proper action of the anterior lobe hormone in lactation.

The duality of the ovarian secretion would, therefore, seem to be established beyond cavil. The follicular phase alternates with the luteal phase; there are two hormones: (1) "Oestrin," "folliculin," "feminin," "theelin"; and (2) a luteal hormone, "progestin," "corporin." They are supplementary. There is no oestrin in Hisaw's corporin, none in Corner's progestin. Fellner's very recent contention that there is one hormone, "feminin," and that this is secreted, not by the graafian follicle but by the corpus luteum seems to us based on slender facts and with a curious disregard of the American work in the field.

The relation of these hormones to menstrual bleeding remains to be discussed.

THE UNDERLYING CAUSE OF MENSTRUAL BLEEDING

It is possible at present merely to pass in review certain experimental data which are fragmentary but which will have to be reckoned with in the construction of any theory of menstruation. The reader should be warned, however, that the authors do not here attempt such a theory; nor is it the object of this chapter to discuss in detail the theories variously proposed. We consider the facts still too meagre to assign to any one factor the essential cause of the menstrual process. The subject is in the formative stage and the theories are useful only in stimulating and directing further researches.

Let us begin by conceding that menstruation may take place with or without ovulation, inasmuch as bleeding and desquamation both occur in either case. If it is objected that the elimination of the corpus luteum in this way is unjustified it may be added that we have the word of Hisaw (personal communication) to the effect that injections of "corporin" are without the slightest effect on the course of either normal or induced bleeding, whereas the follicle hormone does have a patent effect, as will be noted below.

ovaries removed always show some growth of the graafian follicles, but at times this may be very slight (Corner, Allen, Hartman, von Wagener). That these cases of bleeding are to be correlated with the removal of the source of follicular hormone would seem to be justified by the experiments of Allen, who invariably noted bleeding in castrated monkeys several days after the substitutional injection of folliculin or oestrin.

Further presumptive evidence pointing to the importance of the follicular hormone is presented by the careful experiments of Saiki, done in Corner's laboratory. The experiments were designed to test the dispensability of the ovaries for the bleeding process, as argued by Hartman, Firor and Geiling, when anterior lobe hormone is injected. Saiki, however, found no bleeding in castrated animals, whereas 15 to 20 cc. of the follicle extract injected over about a week resulted in a typical bleeding five to seven days after cessation of the injections. Of special significance is the demonstration of some follicular growth of the ovary left in the animal during the injections, as compared with the control removed before the injections were begun. Saiki furthermore showed that the follicular hormone served as an inhibitor of the bleeding; for if anterior lobe hormone is first injected and this is followed by a course of theelin, bleeding may be delayed until several days to a week or more after the last injection. These experiments point strongly to the wave of oestrin (high in the middle, low at the end of the cycle) as the dominant factor in the menstrual process. Medication with this hormone at or near the middle of the cycle, in cases of hypofunction, would seem to be indicated.

In a preceding part of this chapter we have considered the hypophyseal hormone, in its rôle as the "motor" of the ovary. The hypophyseal influence on menstruation would, from what has been said, be an indirect one, acting through the medium of the ovaries. Nevertheless, it is well known that the anterior lobe-ovarian relationship is a mutual one, for the reverse also holds: the ovary affects the anterior lobe. It is quite possible for the follicular hormone to affect the menstrual flow through the medium of the hypophysis. The long period between the application of the hormone and the bleeding that usually occurs may be interpreted in that way. Hartman, Firor and Geiling took this view, basing it upon two findings: (1) The absence of the bleeding after injection of large amounts of theelin (amniotin) in hypophysectomized animals, and (2) the invariable bleeding response with anterior lobe extracts. Menstruation seemed to these workers due not to the absence or failure of something (folliculin) but to a positive factor, the anterior lobe hormone. A recent repetition of the work, not yet completed, again showed a refractoriness to the injection of theelin (amniotin) in a hypophysectomized female, with some bleeding, though less than the typical amount, in 5 cases of castrated females receiving crude anterior lobe extract. However, the same slight bleeding has occurred in two of the same animals receiving liver extract prepared in the same way.

At the present writing it would seem possible that menstrual bleeding is the result of failure of the female sex hormone (folliculin, oestrin, feminim, theelin, amniotin). Whether the hormone acts through the hypophysis, as Hartman, Firor and Geiling stated, or more or less directly on the uterus, remains to be determined.

Such a determination, however, will not solve the essential nature of the menstrual bleeding. Much needs to be explained concerning the intimate

It has been suggested above that the "intermenstrual bleeding" which is seen in both women and monkeys may be explained as due to a temporary failure of folliculin between ovulation and the establishment of a functional corpus luteum. It would thus have one factor in common with menstrual bleeding. Another explanation would link the intermenstrual bleeding more closely with the pathologic type of functional bleeding associated with hyperplasia of the endometrium, which we usually think of as due to excessive or prolonged secretion of folliculin.

Such facts as have been set forth would seem to vindicate the common gynecological viewpoint that the withdrawal of the corpus luteum influence is the responsible factor in the precipitation of normal menstrual bleeding. As this structure, however, contains both progestin and folliculin, we cannot yet be sure as to which is the more important in the inhibition of bleeding, and which, therefore, by its withdrawal, is the factor responsible for menstrual bleeding. For the present, however, the weight of evidence indicates that the important factor in this regard is folliculin.

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and quality of the sunlight, temperature, rainfall, food and many other factors determine and influence the regular recurrence and the waning of the reproductive activity of animals. Most animals, from the lowest to the highest, with the exception of man and perhaps most primates (Zuckerman), thus have a well-defined and limited breeding season; the continuous breeders, aside from the domestic animals, are the exception (Marshall, Zuckerman).

The breeding season is ushered in by the so-called "sexual season" (Heape, 1910) when migration, the search for mates and copulation occur. During this time the primary sex organs, the gonads, recover from the degenerative condition of the "resting" season and in turn stimulate the accessory reproductive glands and organs (seminal vesicles, prostate gland in the male, the genital tract, mammary glands, etc., in the female) to growth and secretion. Secondary sex characters, such as nuptial color in fishes, clasping organs in frogs, courting plumage in birds, antlers of the stag—all come to full elaboration under the influence of the internal secretion of the gonad, especially the testis, since the gaily adorned and combative mate is usually the male in all vertebrates. Naturalists have described these changes and, chiefly on teleological grounds, less often on experimental evidence, have postulated the purposiveness of the evanescent equipment of the male in the economy of the species. The physiologist has, however, been able to demonstrate the causal relation of gonadal secretion to the development of the secondary sex characters. The behavior of the sexes toward each other, or the mating instinct, may likewise be considered a secondary sex character conditioned upon internal drives of endocrine origin.

FEATURES OF THE SEXUAL CYCLE COMMON TO THE CLASSES OF VERTEBRATES

It is to be noted that throughout the vertebrate series, in the infinite variety of forms which this phylum includes, from fish to man, the essential reproductive organs are for the most part built upon a common pattern, and the reproductive endocrines have analogous functions throughout. The points of resemblance represent the fundamentals; the points of differences are instructive and aid in the analysis of cause and effect. Some of the former, because of their widespread occurrence, are listed below. They should serve to emphasize the fact that man is "common clay" with the lower vertebrates, not set off as something different, as the clinician who deals with but that one species is only too prone to assume.

1. The gonads arise in all vertebrates in the same relative portion of the celom, medial to the wolffian body. Primordial germ cells migrate into them and new germ cells proliferate from the germinal epithelium in the same fashion in man as in the lower animals.

2. Spermatogenesis proceeds everywhere after a typical manner.

3. Oogonia, in numbers characteristic of the species, begin a period of growth in the ovary under rhythmic stimuli and undergo similar changes, whether the egg be a large yolk-filled one or microscopical in size like that of the mammal. Among all mammals the graafian follicle is essentially the same structure in such widely different species as the opossum, the mouse, the cow or the human female.

many times as far as during the interval. This constitutes one of the most interesting correlations yet made in the realm of animal behavior. (*Cf.* Richter, 1927.)

THE OESTROUS CYCLE

As implied in the preceding sections, most animals have a limited mating time. This may be once a year, as in fishes, amphibia, reptiles, most birds, and many wild mammals. This animal rutting season is truly a striking phenomenon, especially in the larger spectacularly combative mammals.

The females of domestic mammals as well as some wild species, however, experience short recurrent periods of heat or oestrus throughout all or most of the year. The time between two successive heat periods at which the female accepts the male in copulation is known as the oestrous cycle. The periods are often remarkably regular. But regardless of length, the cyclic changes do not appertain merely to the periodic recrudescence of sex behavior but involve gross and microscopical changes in the reproductive organs, including the mammary glands. Perhaps more than minor changes are also invoked in the vegetative organs generally. The changes are those calculated to adapt the organs—and the soma in general—for the care and nurture of the fertilized ovum.

The question is often asked: What initiates the cycle—the first cycle at puberty, the first cycle of the breeding season? Thus far it can only be stated that the rhythmicity is due to an interplay of the gonad and the anterior pituitary with other endocrines playing minor rôles.

The methods of studying the cycle have been largely histologic and these are stressed in the following characterizations of the phases of the cycle. The vaginal smear method is by far the quickest and easiest but according to some authors gives an inadequate notion of the effect of experimental procedures, since the vagina is probably more sensitive to the follicular hormone, the uterus to the corpus luteum hormone. The older method of measuring and weighing the uterus certainly offers supplemental and useful data.

Guttmacher's study (1926) of vaginal leukocytes in vivo the writer has fully verified for the rat and had applied the method to the monkey. No one else seems to have utilized the method. In the rat actively motile leukocytes are found in the vagina only in the metoestrum.

One of the most important developments in the physiology of the smooth musculature of the genital tract is the demonstration by Kok and Bergmann of the cyclic changes in the calcium and magnesium ion content of the uterine tube. Magnesium, the inhibitor, is lowest at oestrus, calcium, the accelerator highest; in the metoestrum, when the tube is most sluggish, the opposite conditions prevail. Further studies in this direction are needed.

It has been found convenient to subdivide the cycle into several phases according to major events which characterize the reproductive organs, especially the ovaries, the uterus, and the vagina. The nomenclature proposed by Heape (1900) is now generally followed.

Oestrus.—This is the "heat" period or time of acceptance of the male. Normally one finds in the ovaries one or more graafian follicles approaching maturity at the time of oestrus and rupturing toward the end of the receptive stage of the female or immediately after. In the rabbit, the ferret, and the cat, copulation is normally necessary for ovulation. In the rabbit this

more succulent and highly secretory. The mammary glands likewise show much greater proliferation as compared with the oestrous condition. The vaginal epithelium tends toward mucification. The epithelium of the oviducts is reduced to half its thickness, casts out cells bodily, secretes. On the whole, the changes are much like those of early pregnancy, hence the term "pseudopregnancy."

Pseudopregnancy is most marked in marsupials (Hill and O'Donoghue, Hartman). In the dog pseudopregnancy occurs in every nonpregnant cycle (p. 368). In the rabbit and the rat the condition may be brought about by a sterile mating, as with a vasectomized male. In the rat, mechanical stimulation of the cervix, as by means of a glass rod, brings about pseudopregnancy lasting about twelve days. The rat's cycle is thus lengthened from four to twelve days. By virtue of its luteinizing action on the granulosa of the follicle, the urine from a pregnant woman likewise brings about a long cycle and pseudopregnancy.

In the human and monkey females the premenstrual or pregravid changes of the endometrium following ovulation are the equivalent of pseudopregnancy, and are subject to the same controlling factors.

CYCLIC CHANGES IN THE PHYSIOLOGIC CONDITION OF THE GENITAL MUSCULATURE

In the preceding brief résumé of the oestrous cycle anatomical considerations were emphasized. Since Blair, in Evans' laboratory, discovered that the stage of the rat cycle determined the character of the spontaneous contractions of excised strips of uterine muscle suspended in oxygenated Ringer's solution (Magnus' method), the method has been applied in numerous studies both to the uterus and to the fallopian tube. The problem of sperm and egg transportation, whether by ciliary action or by muscular peristalsis, still remained to be solved. Blair found the uterine rhythm slowest at oestrus, fastest in the interval. Keye (1923) found the same obtained in the pig, but noted that the amplitude of the recorded curves, *i. e.*, the power exerted by the individual contractions, was much greater at oestrus. Calculating the work done at different stages of the rat cycle, Harne (1931) reported this to reach the minimum of 12 gram-centimeters at oestrus, a maximum of 75 at the end of the cornified stage, and to grow gradually less during the di-oestrum.

The differential action of the longitudinal and the circular layers of the uterus have not been analyzed, though Sun (1925) noted certain differences in the pregnant uterus. It is of interest to the obstetrician that by the method employed by Sun the passive behavior of the lower uterine segment in pregnancy was demonstrated.

Wislocki and Guttmacher (1924) confirmed these findings by careful direct observations on the excised whole uterus and fallopian tubes of the sow. Similar cyclic changes in the response of the fallopian tube have been noted since Seckinger's studies on the sow's tube. This is most active at oestrus and the intensity of the contractions gradually subsides in the metoestrum. According to Kok (1926), this subsidence of the tube is rather sudden following ovulation and the sluggishness continues while the eggs are in the tube. Hence, according to Kok, their slow transportation and long sojourn (three days) in the tube.

In the opossum the cycle is about a month in length and recurs, in the absence of pregnancy and lactation, at least from February to September. The vaginal smear discloses the stage of the cycle as clearly as in the guinea-pig. Before the discovery of the vaginal smear method in 1917, the writer used the mammary thickening, determined by palpation, as a criterion for the stage of pregnancy or pseudopregnancy; for the two conditions are indistinguishable in the opossum, as Hill and O'Donoghue also found to be the case in *Dasyurus*. The period of gestation in the opossum is twelve and one-half days only (!) and pseudopregnancy lasts about as long. Both the uterus and the mammary glands participate in the hypertrophy following ovulation, which is spontaneous; hence it is not possible to determine by external appearances whether a given uterus contains embryos near term or only unfertilized eggs. What makes the mammary glands adapted to diagnostic purposes by palpation is the fact that, being confined to the pouch, they grow in thickness rather than in lateral extent, hence slight changes are readily detectable by the trained palpating fingers. This sensitivity of the mammary glands of the marsupials to growth stimuli (they must be ready for lactation twelve and one-half days post coitum) would seem to render the opossum a favorable experimental animal for certain lactation studies (Hartman, Dupre, and Allen, 1926).

Lagomorpha (Rabbits and Hares).—The domestic rabbit is one of the most commonly used laboratory mammals. It is not only easily kept but its reproductive behavior makes it peculiarly adapted for certain studies. The doe will not ovulate spontaneously but only after certain treatment. Normally she ovulates after coitus; and since she will ovulate pretty certainly about ten hours later, one is practically certain to find eggs at any desired stage in the tube or the uterus. Heape and others have taken advantage of this fact in transplanting ova from one female to a foster mother. The animal is also a favorite subject for investigating the relation of the corpus luteum to the progress of gestation (see article by Corner, these volumes).

How copulation brings about ovulation in the rabbit has been a matter of speculation. It is now known that it is connected with the anterior hypophysis. Perhaps orgasm, as such, in animals and as well in women, stimulates the hypophysis. At any rate, it was found by Friedman that the human urine of pregnancy, injected intravenously into a favorable doe, would bring about ovulation; anterior lobe extract has the same effect. The Friedman pregnancy test is well-nigh perfect provided a favorable female, preferably one several days post partum, is employed; for, in common with the rodents, the rabbit is ready to ovulate at the time of parturition.

Inasmuch as the time of ovulation can be predicted to a nicety in the rabbit, Walton and Hammond (1928), likewise Kelly (1931), were able to make direct observations upon the opening of the follicle, which is slow, like the opening of an abscess, and not explosive, as had been supposed (*cf.* Hartman, 1932).

The rabbit can, moreover, be made to ovulate with urine concentrate during pregnancy. Taking advantage of this fact, Wislocki and Snyder (1931) were able to produce cases of superfetation; hence the possibility of the spontaneous occurrence of this mooted phenomenon in man must be conceded.

The nonpregnant rabbit is supposed to be in heat, ready to ovulate,

The male guinea-pig has been found a convenient test animal for assaying the male sex hormone. After castration, the semen ejaculated in response to a generalized electrical shock, after the method employed by Moore and co-workers, suffers a gradual reduction in amount, soon reaching zero. This is due to the progressive atrophy of the seminal vesicles and the prostate gland, which are, however, perfectly restored by means of injections of the male sex hormone (Gallacher and Koch), and the amount of the ejaculate increases concomitantly. The guinea-pig thus neatly supplements the cockscomb test worked out by Domm, Lillie, Juhn, and Koch.

Carnivora (Cat, Dog, Ferret).—*Cat.*—Little is known concerning the oestrous cycle of the cat. About four cycles occur in the course of a year. Heat lasts a number of days. Ovulation requires the stimulus of coitus (Longley). The long cycles and the relative difficulty of keeping cats, the most feral of our domestic animals, has militated against the adequate study of this interesting species.

Ferret (Putorius).—There are certain peculiarities in the oestrous cycle of the ferret which render it especially instructive. Despite the fact that the species has been subject to domestication for centuries, its reproductive habits do not seem to have changed, for it goes into hibernation in captivity and has but one breeding season, April to August. During this time the female is in continuous heat unless copulation takes place. Heat is manifested externally by the hypertrophied vulva, which may enlarge fifty times over the anoestrus size. It retrogresses during pregnancy and pseudopregnancy, which for five weeks are indistinguishable in the development of the mammary glands and the uterus. At the end of this time the corpus luteum has attained the height of its development and has begun to break down—pseudopregnancy is at an end or, in case of pregnancy, parturition is imminent. The follicular phase causes some growth of the lower layer of uterine glands but none in the mammae. As in the opossum, lactation in the entire absence of corpora lutea is sufficient to inhibit the ripening of new follicles, *i. e.*, lactation absolutely abolishes the cycle.

Just what the time relation of copulation to ovulation is is not known. Marshall and Robinson are at variance on this point. Hammond and Marshall ignore the problem.

It would appear from the facts presented that the oestrous phenomena displayed by the ferret are confirmatory to Loeb's suggestion that the follicular phase affects chiefly the vulva and the vagina, the luteal phase chiefly the uterus and the mammary glands.

Dog.—The oestrous cycle of the dog has been much studied from Bischoff's time on. The center of interest has long been the bleeding of the pro-oestrum, which Bischoff and his followers, including the gynecologists, homologized with menstruation. Hence, since Bischoff determined that in the dog heat and ovulation follow soon upon the pro-oestrous bleeding, he reasoned that ovulation and menstruation in the human are closely associated in time and physiologic causation, and—as so often happens—Bischoff found plenty of cases to support his viewpoint. It was with the greatest difficulty that gynecology freed itself of the domination of this interpretation, an achievement only recently attained.

The dog cycle has recently been reinvestigated by Evans and Cole and certain details determined with greater definiteness than heretofore.

of the sow tube at oestrus are the same as the human tube of the mid-interval, a conclusion corroborated in a monograph by Novak and Everett (1928).

The uterus of the pig undergoes definite but much simpler changes in the course of the cycle than those of the dog uterus, probably in correlation with its diffuse mode of implantation. The epithelium of the uterus, like that of the tube, thickens greatly toward the time of oestrus, more than doubling that of the di-oestrous or the pregnant condition. From the eighth day of the cycle on, the epithelial lining thins out and by the eleventh day has attained the minimum of the nonpregnant cycle. The tips of the cells have peculiar processes which seem to be associated with a secretory activity. In pregnancy these changes are progressive.

The accurate data now available on the pig and the ease of securing the material renders this species a favorable subject for both histologic and physiologic studies on the genital tract. The work of Keye, Corner, Seckinger, and of Wislocki and Guttmacher may be cited by way of illustration.

Sheep.—The domestic sheep also has a cycle of about twenty-one days. Oestrus is distinguishable externally by a swelling of the vulva, the flow of mucus and by the ewe's sex behavior. It is probable that occasionally there is a show of blood; but some extravasation probably always takes place in the uterine stroma at heat, if we are to reason from the appearance of blood pigments in the endometria described by Bonnet, Kolster and others. Recently Fred McKenzie (Columbia, Mo.) has made some experiments upon sheep, checking his observations by repeated laparotomies on the same animal, with recovery of eggs. Ovulation occurred twenty-two to thirty hours after the beginning of oestrus. This work will furnish the most accurate information yet available on the species. Sheep ova have been studied by Bischoff, Bonnet and Assheton (*cf.* Hartman, 1929).

Cow.—In the case of the cow we have the advantage of Hammond's monograph "Reproduction in the Cow." The oestrous cycle and the progress of pregnancy are well described, details being given for the ovaries, including the corpora lutea, and for the uterus, the cervix and vagina, and the mammary glands. Küpfer had previously published a good description of the ovarian changes with plates in color. The first tubal ova of the cow were recovered by W. H. Lewis and the present writer in collaboration with F. W. Miller and W. W. Swett. Ovulation appears to take place, as expected, toward the end of the heat period.

Monkeys and Apes.—That primates have a limited breeding season is denied by Zuckerman, who holds that conceptions are scattered uniformly over the year. He considers this a primate character; it is therefore, he would advise, needless for the anthropologist to look for seasonal fertility in man. The present writer, however, believes that the data for all monkeys are insufficient to prove Zuckerman's contention except for the rhesus monkey, and in this case all facts point to an anoestrum in summer, with the most favorable months from September to January. The sterility of the summer months in the Carnegie monkey colony has been found due to the failure of the monkey to ovulate, even though menstrual cycles continue at this time. This low ebb of sexual activity in the summer months the research worker will have to consider in planning work on the physiology of reproduction in monkeys.

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CHAPTER XI

SEXUAL INTERCOURSE

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Introduction.—Text-books on gynecology and obstetrics can scarcely be said to have kept pace with popular literature and the press in the increasing freedom now exhibited in the discussion of sex problems. This must impress one as a rather curious attitude toward a function which may, in a sense, be said to be the *raison d'être* of both these specialties, and one whose fundamental importance is self-evident to both physician and layman. No physician can have failed to be impressed with the intertwining of the sex factor with many of his daily problems, and yet the discussion of this question has been relegated to a few special works, or to unauthoritative volumes, prepared chiefly by laymen, on "what the husband—or the wife—should know about married life." It is refreshing, therefore, that the past year or two has seen the publication of at least two excellent studies of this subject, one by Van de Velde and the other by Dickinson and Beam. The inclusion of a very short discussion in the present work not only needs no apology, but would seem to be clearly indicated. For a fuller discussion the reader may be referred to special works, such as the volumes referred to above.

Definition and Purpose.—Sexual intercourse is defined by Van de Velde as "the full range of contact and connection, between human beings, for sexual consummation." Its biological purpose is of course the propagation of the species, but it is obvious that, as carried on throughout the human race, the immediate purpose of the act of coitus is most often the gratification of the sex impulse innate in practically all normal human beings. This detracts in no way from the nobility of the function in marital life, for the sex impulse under such conditions is the supreme expression of love between man and wife. That the function is very often prostituted to a much lower animal level, so that the element of love does not enter into the picture, calls for no argument.

In women, the underlying biological purpose of the sex act is perhaps more often manifested than in men, for the female craving for maternity is certainly more highly developed than the desire for paternity among men. The degree of desire for children among wedded couples is of course an extremely variable one, depending upon individual factors, often social and economic. That it exerts an influence upon sexual desire and gratification between the partners permits of no doubt. Conversely, female sex frigidity or revulsion is frequently directly traceable to the overpowering dread of impregnation. This aspect of the subject, however, is discussed in another chapter, while here we are more concerned with certain elementary considerations concerning normal sexual intercourse.

Technic of Coitus.—Crudely expressed, the immediate "goal" of normal human coitus, so to speak, is introduction of the penis into the vagina, and

and cervical glands, are increased. Under ideal conditions the acme of the act, the orgasm, takes place simultaneously in both partners. This, in the woman, appears to be precipitated by repeated impact against the cervix and vaginal vault, and, presumably through psychic channels, by the appreciation of the convulsive movements accompanying the male orgasm (Van de Velde). The "discharge" accompanying the female orgasm is evidently the discharge of the glands above mentioned, especially the vulvovaginal and cervical glands.

Following the orgasm there comes a fairly rapid detumescence in both sexes, accompanied by a sense of pleasurable exhaustion and relaxation. This third stage of the ideal sexual intercourse, designated by Van de Velde as the "afterglow," is a not unimportant one, constituting an epilogue only less important than the prelude already described.

It has been rather difficult to sketch even thus cursorily the mechanism of the sexual act, for no human function is of course so intimate and so individual in its characteristics. The vital importance to many of our patients of at least some knowledge of such matters, and the knowledge that a not inconsiderable fraction of the ills we encounter in our consulting rooms revolve about the problem of sex, makes it necessary for the physician to play the part of the wise counselor in many cases. One need not be a freudian to appreciate the general importance of this problem.

The value of simple and dignified instruction along this line is especially obvious from the standpoint of the newly wedded couple, or the couple who are contemplating marriage. Inexperience in sex matters may be the cause of much unhappiness to both husband and wife, and the physician, who often is given the opportunity of advising the young husband and, less frequently, the young wife, can often make a genuine contribution to their future happiness. Much has been written about this subject of premarital education in sex matters, particularly by Dickinson. When carried out wisely, conservatively and sanely, its importance must be obvious.

Normal Frequency of Coitus.—The frequency of coitus depends on many and varied factors. The physical and constitutional make-up, the degree of libido, and environmental conditions differ markedly in each individual. Strong robust persons often have a very slight sexual urge; in contrast it may be highly developed in small, weak and apathetic individuals. One of our colleagues tells of a patient, a not too robust farmer, who says he has had sexual union every night of the twenty-five years of his married life, with entire satisfaction to both partners. City life, with its hustle, bustle, noise and attendant worries appears to lessen desire, for studies of a large series of urban and rural couples indicate that desire for and frequency of intercourse are greater among the country folk.

Most writers on the subject agree that under ordinary conditions sexual union twice a week represents an average norm of frequency after the glamour of newly married life has worn off. Dickinson and Beam found two to three times weekly to be the usual practice in a series of 526 normal married couples. It need hardly be mentioned here that the newly married husband should be cautioned against too frequent and too vigorous satisfaction of his desires, to avoid undue trauma of the genital organs of his bride, as well as for rather obvious psychic reasons. Married couples should realize that for ideal sexual union each partner must derive the fullest amount of

movements of the cilia on the tubal fimbriae, especially on the fimbria ovarica. As regards its propulsion along the tube, there is some difference of opinion as to the relative importance of tubal peristalsis, on the one hand, and ciliary movements on the other. Until recently, the latter factor was looked upon as more important, but there are many now who consider that the muscular movements of the tube play a very important part. Probably both are concerned. This whole problem of germ cell transportation is here touched upon only very lightly, for it is more fully discussed in another chapter.

Physiologic Basis for Libido.—There is little knowledge and there are only a few plausible theories as to the physiologic basis of sex desire. Except some areas in the spinal cord which are commonly spoken of as "sex centers" there is no anatomical basis for such considerations. Certain areas in the brain have been alluded to as the center of libido, but all writers on the subject fail to give proof of their theories. Since confirmation of all theories is lacking it is perhaps best to look upon the basis of sex desire as a correlation of a number of factors, *e. g.*, the psyche, the sense centers, glands of internal secretion, etc.

Since there is such a wide variation in the make-up of every individual there is necessarily a similar variation in the sex make-up. Psychic impressions, taste, smell, sight and touch, as well as the effect of the secretions of the ductless glands, go together in forming in the individual the basis of libido. Space does not permit the discussion of the influence of each separately. The reader is referred to the works of Van de Velde and others for a more detailed discussion of this obscure subject.

The influence of the internal secretions seems to be a much more direct one in the case of the lower animals than it is in the human. Oestrus, for example, appears to be due to the presence of folliculin. Because of this, removal of the ovaries brings about an abolition of the oestrous cycle. Certainly this is not the case with the human. In the latter, for example, there is no such clearly defined thing as a period of "heat" or "desire," for coitus is permitted by the female in any part of the reproductive cycle.

Castration in the female may, it is true, be followed by a lessening or even disappearance of the libido, but there are so many exceptions to this that the essential importance of the ovarian secretions can scarcely be predicated. The same thing may be said as to the normal menopause. In the male, however, castration characteristically produces loss of sex desire. Again, other internal secretions, like those of the thyroid and pituitary, undoubtedly are of some importance, to judge from the frequent effect of dysfunction of these glands upon the sex function. The subject is therefore a very confused one as yet, the evidence suggesting that the sex feeling is one which is deeply rooted in the entire endocrine and psychic structure of the body.

Optimum Time for Coitus for Fertilization Purposes.—While the subject is more fully discussed in another chapter, it may be briefly summarized in this. The fact that ovulation occurs usually between the tenth and twentieth days of the cycle, and most often at about the thirteenth or fourteenth day, and the further fact that the ovum is now known to survive only a very short time after its discharge from the ovary, would at once suggest that the optimum time for coitus is at or near the usual ovulation time, *i. e.*, from the tenth to the twentieth days, and especially at about the thirteenth or four-

SECTION III

MORPHOLOGY AND PHYSIOLOGY OF PREGNANCY

CHAPTER XII

MATURATION AND FERTILIZATION OF THE OVUM

By Carl G. Hartman, Ph. D., and Bradley M. Patten, Ph. D.

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"There is perhaps no phenomenon in the field of biology that touches so many fundamental questions as the union of the germ cells in the act of fertilization; in this supreme event all the strands of the webs of two lives are gathered in one knot, from which they diverge again and are rewoven in a new individual life-history. . . . The elements that unite are single cells, each on the point of death; but by their union a rejuvenated individual is formed which constitutes a link in the eternal procession of life."—F. R. Lillie, in "Problems of Fertilization."

The subject of this chapter constitutes a relatively recent development in biological science. The reasons are not far to seek—the discovery of the rôle played by spermatozoa awaited the development of microscopical technic sufficiently fine to follow the behavior of these minute bodies within the egg. It is true that spermatozoa were discovered as long ago as 1677 by Hamm, a pupil of Leeuwenhoek; but the mammalian egg, though seen in the rabbit tube as early as 1797 by Cruikshank, was not correctly interpreted or its source in the ovary discovered until 1827 (von Baer). Sperms were seen in rabbit eggs by Martin Barry in 1843; they were observed actually entering the frog egg by Newport in 1854. But it was not until 1875 that Fol and O. Hertwig independently discovered the cellular basis of fertilization. It may be said, therefore, that morphologically at least, fertilization is now fairly well understood.

It is not surprising, then, that the discovery of the mammalian egg was so long delayed, for the mammalian sex cells are of an astonishingly small size, which the layman as well as one who looks at them habitually with the aid of a modern microscope can realize with difficulty. A simple comparison may, however, help one to visualize the minuteness of the egg of mammals. The comparison holds for all mammals, for in this group the embryo lives at the expense of the mother, hence the egg has been reduced to approximately the same size in all mammals from mouse to man and man to whale (Fig. 153).

"Let us assume that the entire human race comprises in the aggregate two billion individuals. Suppose one could assemble in one place all of the eggs from which will arise the next generation of mankind—2,000,000,000 eggs. How much space would they occupy? Would they amount to a houseful, or a roomful, or a hatful? The last guess is right—a derby hat would suffice.

are called *somatic cells.* Thus, among the myriads of cells that make up the individual and the organs that maintain his vegetative existence (brain, liver, heart, kidneys, bone, etc.) there are the same limited number of germ cells that function in the perpetuation of the race—an unbroken line that has existed since the beginnings of life on earth. The conjugating gametes alone pass on the entire hereditary dowry of the species, not only from the immediate parents, father and mother, but from all their ancestors. It is readily apparent, therefore, that each person is a mosaic of his past. Looking ahead instead of backwards it is equally apparent that the entire future of any species depends on the germ plasm held in trust within the bodies of the individuals now living. For this reason the germ plasm is of paramount interest to all thinking persons. Whatever changes for good or ill the germ plasm undergoes will inevitably be written into the history of the race.

Heredity and Environment.—Volumes have been written as to whether heredity or environment has the greater influence on the individual. The controversy arose, of course, chiefly in connection with man's mental life, where education, both in and out of school, plays such an important rôle in mental development. The matter is further complicated by the genetically mixed character of human beings, for *Homo sapiens* is far from "sapient" with regard to selective breeding. Since all of us are "mosaics" in inheritance, feebleminded offspring may appear in intellectual families and highly successful sons and daughters in the homes of the obscure. Yet by and large "like begets like" and that child must be considered fortunate who has "selected his ancestors" with the greater number of "good" traits to "take after." Brother and sister marriages as practiced by ancient Egyptian dynasties, and brother and sister matings as have been carried out experimentally on rats and other animals, are not in themselves disastrous if the stock is good to start with; but if it is defective, close inbreeding, even among cousins, brings out the defects and may soon annihilate the line.

The environment is as important as heredity in the physical development of the body as well as the mind. For example, the lens of the eye grows from the skin where this is stimulated by the retinal outgrowth of the brain underneath. The skin from the back transplanted over this optic vesicle will likewise grow a lens; or once started, the skin thus sensitized by the optic cup, if transplanted to the back, continues to grow a lens in the abnormal situation. Every part of the developing organism thus grows and differentiates in relation to its environment. "Organizers" doubtless make themselves felt in directing the growth of parts, but the importance of environment must not be overlooked because the manifestations of heredity are more obvious and dramatic.

The germ cells, which are at once the bearers of hereditary traits and the raw material on which environment works, are carried in the gonads. In the gonads (ovaries and testes) there are also large numbers of somatic cells that support, nourish and direct the fate of the germ cells. Each germ cell has its inheritance, which makes it develop, if it becomes a functional gamete, almost exactly as its lineal ancestors did before it—"almost exactly," for in some yet unknown way some germ cells do change, as evidenced by the fact that species have "mutated" and are still in the process of mutating. Many attempts have, moreover, been made to "modify" the germ plasm experimentally to produce "mutations," new individuals different in some particular

its identity, becoming indistinguishable from somatic cells, only later to differentiate again into recognizable germ cells? These phases leading up to the final maturation and liberation of the gametes in the adult are at the present time far from being thoroughly worked out.

For all vertebrates, including man, there have been described in very early stages certain large cells that become differentiated from their neighbors. This happens long before it is possible to tell whether an embryo is to become male or female, indeed before a gonad is laid down. These large cells have been identified by some investigators as primordial sex cells and are believed to have been traced in the chick from the yolk-sac entoderm, through the blood stream to their final situation in the gonad. This interpretation is illustrated schematically in Fig. 154. In various mammals as well as in the human embryo such primordial sex cells have been described in the primitive gut, in the mesoderm surrounding it, and finally in the epithelium of the developing gonad. The definitive germ cells, male or female, are supposed to arise by successive mitotic division from these primordial germ cells.

There are those investigators, however, who deny that these cells are germ cells, while still others grant that they may belong to the germ cell line but contend that these particular cells die and are resorbed. The definitive germ cells are said by this school to come from new generations of cells that grow down from the germinal epithelium into the substance of the gonad. Whether or not they are descendants of these much discussed large cells of yolk-sac origin, primordial germ cells very early become recognizable in the germinal epithelium of the gonad and great showers of them do grow from the germinal epithelium into the underlying stroma of the gonads.

Three proliferations from the germinal epithelium are described: (1) A generation that occurs before a sex difference is apparent. These become organized into tubules. In the male the tubules contain differentiated sex cells and become the seminiferous tubules. In the female the tubules persist in the medullary portion of the ovary as the medullary tubules. Their hypertrophy in tumors is supposed to cause the appearance of male secondary characters in women. (2 and 3) In the female two additional waves of proliferation from the germinal epithelium are described. In the rat, for example, the one is completed before birth, the other occurs between the thirtieth and forty-fifth day of postnatal life. In man both the corresponding waves of proliferation are completed before birth; and since Waldeyer (1870) it has been the current notion that a girl is born into the world with all of the eggs which she will ever have. These ova are supposed to lie dormant until they are stimulated in groups to develop to varying degrees only to undergo degeneration or, once a month, singly to reach maturity and be liberated by ovulation. Some eggs would thus lie dormant for forty-five to fifty years.

Evidence has recently been adduced, however, which tends to show that unfertilized ova are among the most short-lived cells of the body (Allen, 1922; Evans and Swezy, 1931), that the eggs in the ovary today are practically all doomed to die during the succeeding sexual cycle, only to be replaced by new proliferations from the germinal epithelium (Fig. 155). This process is described as a cyclical one and as continuing throughout the life of the individual. According to this view, the human female develops, not merely the meager half million which the newborn infant possesses, but millions

The Chromosomes.—If we look over a microscopical section of a fully differentiated organ like the liver or the kidney, almost all of the gland cells possess nuclei in the resting stage—vesicles filled with a clear matrix or sap in which float granules caught on a reticular framework. The granules take on basic dyes, hence are called *chromatin* granules. But in a growing embryo or in a continuously proliferating organ like the testis or the ovary a large proportion of the cells are in the process of mitotic division, as evidenced by

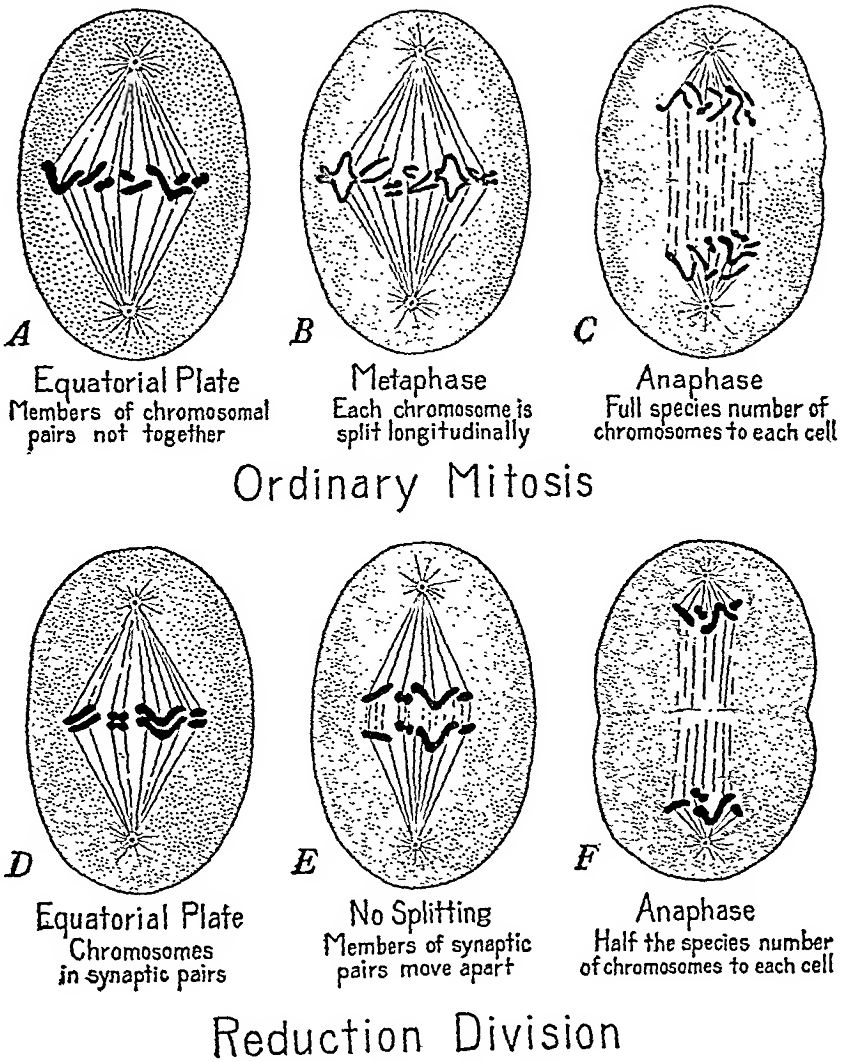

Fig. 156.—Diagrams showing schematically the difference between a reduction division in the process of maturation and an ordinary mitotic division. (From Patten, "Embryology of the Chick," published by P. Blakiston's Son & Co., Inc.)

the division figures scattered about. In these the chromatin is condensed into bodies of varying length and shape, the chromosomes. These are the most remarkable structures yet discovered by the aid of the microscope. Because of their behavior in cell division, in the maturation of the germ cells, in parthenogenesis, in relation to genetics, it is certain that the chromosomes play a most important part as determiners of development. Some of the evidence might be briefly listed.

3. Geneticists confirm the findings of the cytologists. The hereditary principles or "genes" are thought of as self-perpetuating chemical bodies in the chromosomes, each gene determining each particular "unit character." The genes for different characters are situated each in its own part of the chromosome, as determined by breeding of organisms and microscopical examination of the germ cells in the individuals that show certain characters that are being studied. If, for instance, to put the matter a little crudely, one finds that a certain chromosome has a knob on its end in individuals that show a certain character and this knob is absent in another offspring in which the character is absent, we may reason that the character is absent because the genes determining its development were absent.

The evidence, therefore, is overwhelming that the chromosomes are the all-important links in the endless chain of heredity—a definite number of pairs maintained constant in all the cells of an individual by mitosis.

Significance of Maturation.—While the maintenance of the species number of chromosomes in an individual is dependent on mitosis, it is preserved from generation to generation by the processes of maturation and fertilization. In the maturation divisions the chromosome number of the gametes is reduced to half the number characteristic of the species. When, in fertilization, a male and a female gamete, each bearing half the species number of chromosomes, unite with each other, the species number of chromosomes is reestablished in the individual of a new generation.

It is in the final two divisions of spermatogenesis and oogenesis that the chromosomes of the gametes are reduced to half the species number. Cytologists have worked out the mechanism of these maturation divisions with great care in many forms. In some forms chromosome reduction takes place in the first, in others in the second maturation division (for cytological details the reader is referred to Wilson's volume). Just when reduction takes place in any particular case is of minor significance. The reduction itself is the thing of interest. Stripped of detail and without reference to the many peculiar modifications encountered in different animals, a reduction division is a mitosis in which the chromosomes are not split in the metaphase in the manner of a somatic mitosis. Instead the chromosomes are redistributed. Half of them go bodily to one daughter cell and half to the other. If the first maturation division is a reduction division the second maturation division is like a typical mitosis with the chromosomes splitting in the metaphase and the daughter cells each receiving the same number of chromosomes as the cell from which they were derived. In contrast to the reduction division this is appropriately called an equation division. Vice versa, if the second maturation division is a reduction division the first is an equation division. Whatever their sequence and whatever the details of the mechanism, the result of the maturation divisions is to *halve* the species number of chromosomes in the mature gametes of both sexes.

In this halving process the way is paved for separating the chromosomal pairs by a special process termed *synapsis* which occurs in the prophase of a maturation division but not in an ordinary mitosis. If we look at the spindle of an ordinary mitosis (Fig. 156, *A–C*) we can perhaps recognize the members of the chromosomal pairs by their size and shape, but the members of the pairs appear to lie scattered in haphazard fashion. Certainly they do not lie next to one another. When, during the prophase, the spireme thread was

way into the particular sperm which alone, out of millions of its fellows, fertilizes the ovum is likewise fortuitous.

"Thus in the game of life, the maturation processes virtually shuffle the hereditary pack and deal out half a 'hand' to each gamete. A full hand is obtained by drawing a partner from the 'board,'—by combining with some other gamete of the opposite sex. Hence offspring resemble their parents because they play the game of life with the same kind of cards, but not, however, with the same hands. The minor differences in offspring, or the variations from the standard type that always go with these basic resemblances, are due to variations in the distributions made in fertilization.

"In this way there is produced sufficient stability to insure continuity and at the same time sufficient variety to insure progress. For the offspring

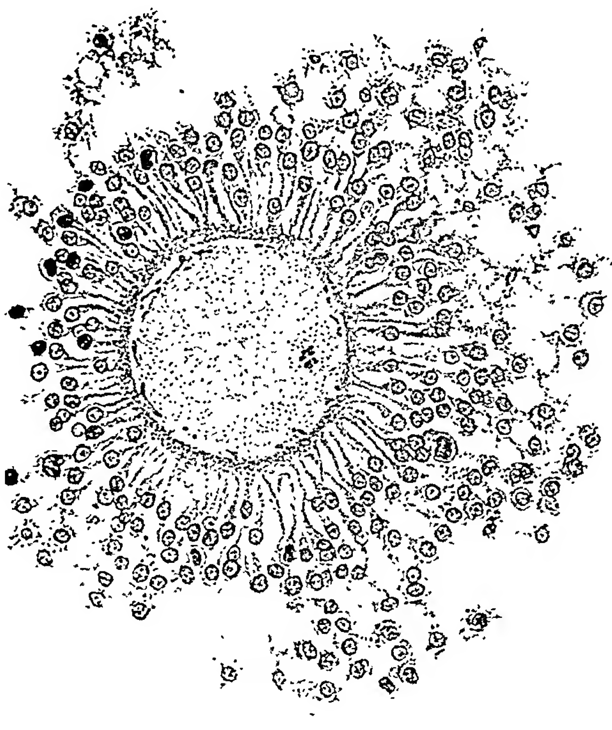

Fig. 160.—Human oocyte with maturation spindle and cumulus cells in the form of the corona radiata; found in 14-mm. graafian follicle. (From Stieve.)

will in the main resemble progenitors which have successfully lived in the prevailing conditions of the past, but will exhibit sufficient variability among themselves to insure that some of them shall successfully live in any conditions likely to arise in the future." (Wm. Patten, "Life, Heredity, and Evolution.")

Maturation of Sperm and Ovum Compared.—Spermatogenesis is continuous in man and other animals that do not have a breeding season. A section through the seminiferous tubules will disclose the process of sperm formation as illustrated semidiagrammatically in Fig. 159. Not all parts of a seminiferous tubule are equally active, but waves of spermatogenetic activity pass along the tubule, hence any given point would seem to act in cycles. The multiplication of spermatogonia, and the maturation divisions and the ripening of the sperms follow in quick succession (Fig. 159). Not so

and the wall of the follicle thins out. Finally, midway between menstrual periods the follicle opens, allowing the liquor folliculi to escape and carry the ovum with it. Ovulation has been accomplished. Out of the collapsed follicle arises the corpus luteum, which "has its day" and finally retrogresses. The story of the follicle is summarized graphically in Fig. 155.

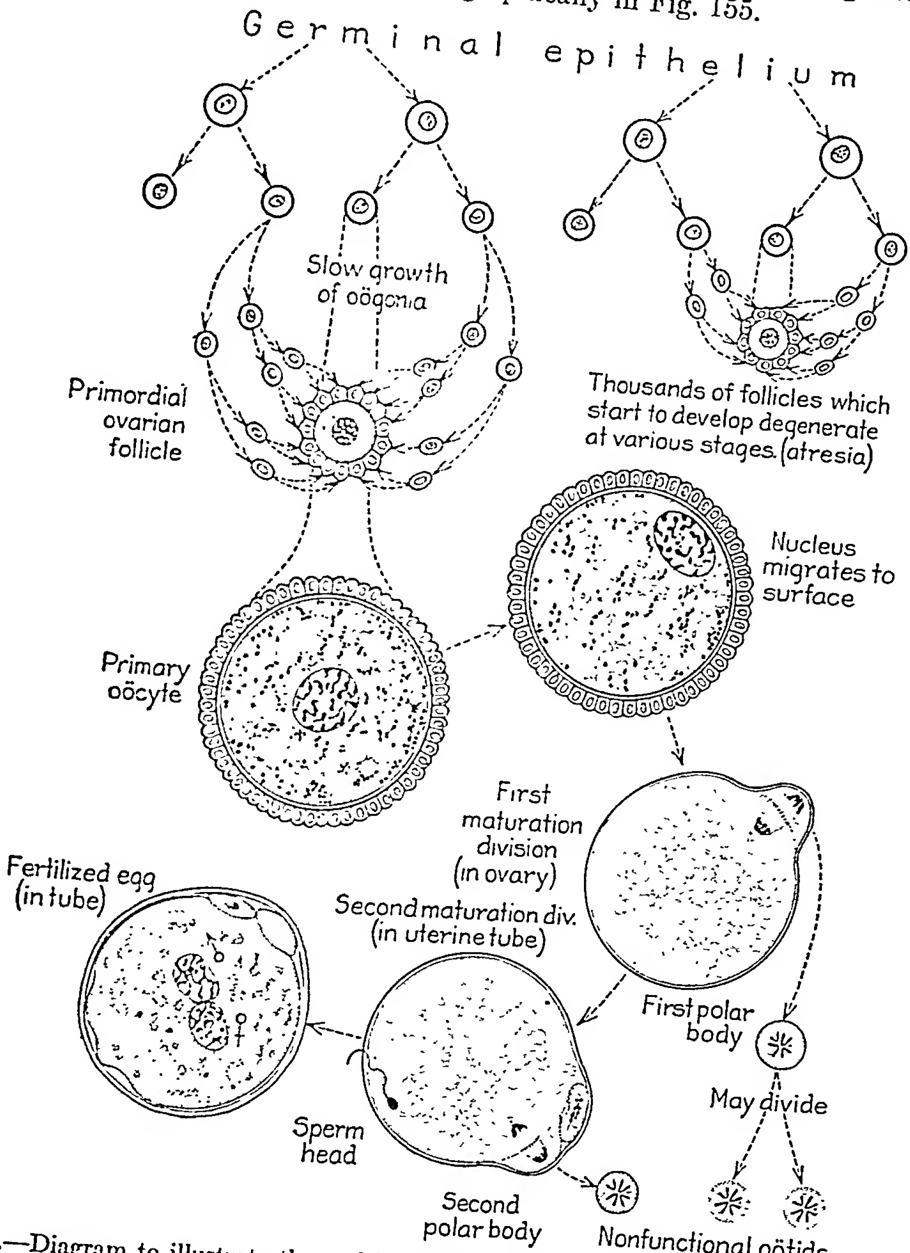

Fig. 162.—Diagram to illustrate the multiplication, growth, maturation, and fertilization of a typical mammalian egg.

Maturation stages of the human ovum have not been secured in sufficient numbers to permit a detailed study of the process. No one has as yet secured a normal ripe graafian follicle from the human ovary. Atretic follicles have been described containing ova possessing polar bodies. The most nearly normal case is that of Stieve, whose figure is here reproduced (Fig.

exists for insuring the safe transfer of the ovum into the tube where it is to be fertilized. Ovulation is not a catapulting process but a gradual opening of the follicle, like the bursting of an abscess. The liquor folliculi that oozes out carries with it the ovum as it leaks out like a miniature viscid cataract over the surface of the ovary. At this stage the ovum is actually within the body cavity. The danger of loss is great. But at ovulation time the follicular hormone is abundant and under its influence the ovarian stalk and the fim-

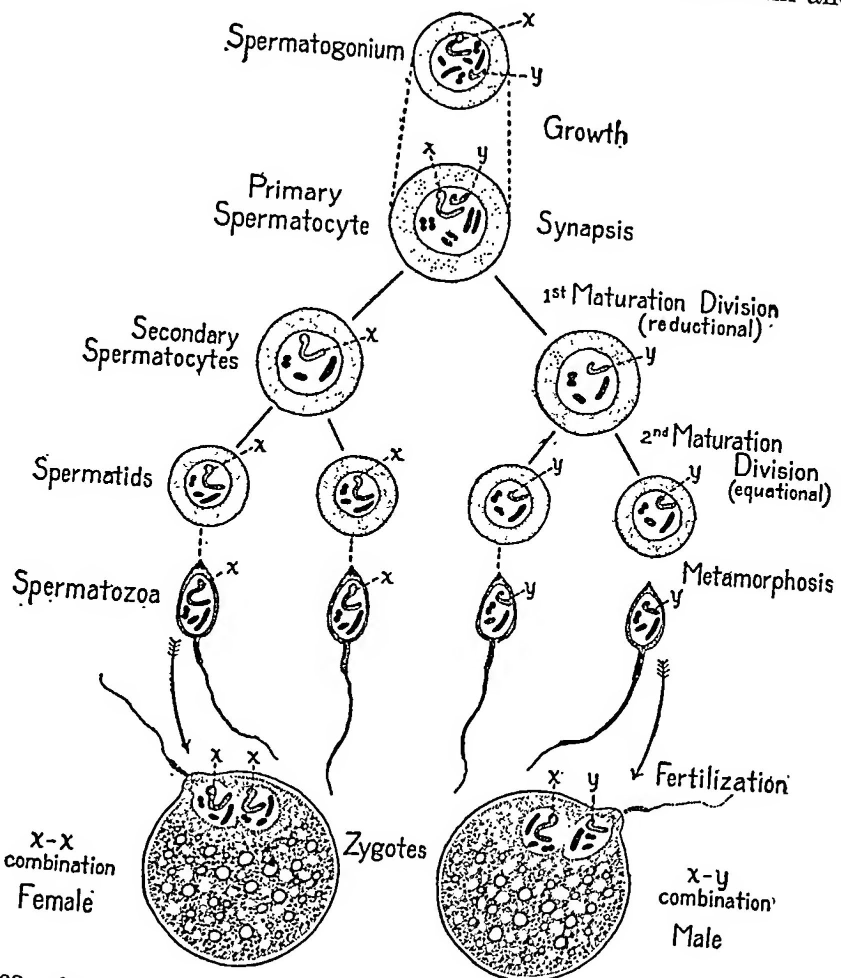

Fig. 163.—Schematic diagram showing the separation of the members of the sex chromosome pair in maturation, and their recombinations in fertilization. It is assumed that the species number of chromosomes is eight and that it is the male which produces gametes of different potentialities with regard to sex determination. The sex chromosomes are stippled; other chromosomes are drawn in solid black. (From Patten, "Embryology of the Chick," published by P. Blakiston's Son & Co., Inc.)

briae of the tube are highly active. The ovary is enclasped by the latter and their movement against the ovary, together with the aid of a ciliary stream, brings the ovum into the infundibulum, whence it is carried down the tube.

The Transport of Sperms.—After semen is deposited in the vagina during coitus (or after artificial insemination) the sperms must pass through the cervix, the uterus and the uterine tube to reach the ovum. It has long been known that sperms are capable of independent motion in a favorable medium

genital tract of women many days (up to 36; Dührssen) after the alleged last coitus. The present writers consider these cases moral and not physiologic issues; for all careful experimental work points to the quick death of sperms in media in which they are very active, for example, in the fluids of the female tract. Sperms, moreover, lose their fertilizing power long before they lose their motility. Sperms that are revived by an alkaline medium or by drugs after attaining the quiescence of fatigue have not been shown to be functional gametes. Because of the great theoretical as well as practical importance of this matter in human reproduction, it is essential that further well-controlled observations be made in women to discover the exact period of viability of spermatozoa in the fallopian tube, uterus and cervix (*cf.* Hartman, *loc. cit.*). In the vagina the sperms are shown to be very short-lived. But whether the ovulatory period (middle of the cycle) is more favorable than the period nearer to the menstrual flow is not known. The pre-

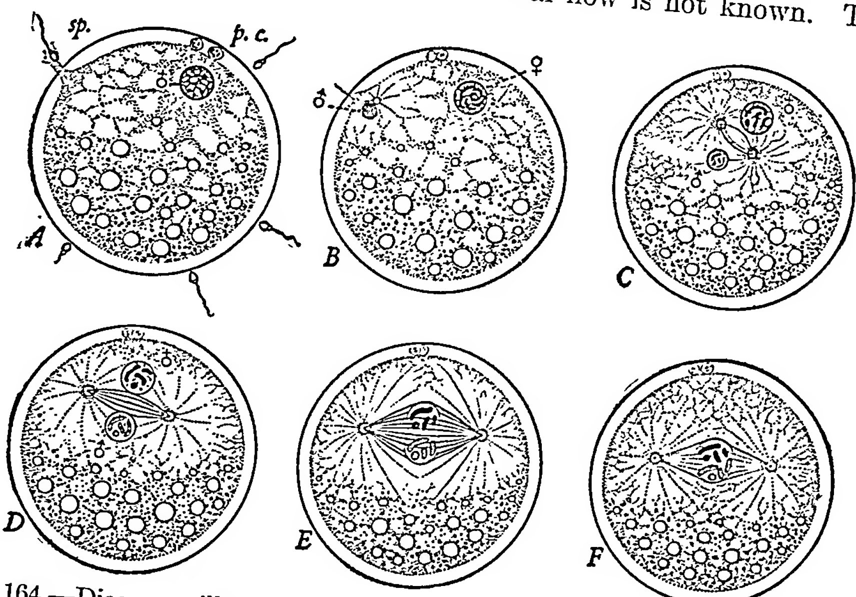

Fig. 164.—Diagrams illustrating schematically the process of fertilization and the formation of the first cleavage spindle. (After William Patten.) As in Fig. 163 the species number of chromosomes is assumed to be eight. Abbreviations: *sp.*, spermium; *p.c.*, polar cell (polar body). The male and female symbols designate the male and female pronuclei respectively. (From Patten, "Embryology of the Pig," published by P. Blakiston's Son & Co., Inc.)

scription of sodium bicarbonate douches in cases of sterility is merely an empirical therapeutic measure. The effect of abnormal secretion likewise awaits the outcome of further and more careful experimentation.

Fertilization.—Fertilization may be defined as the union of the gametes. The term "semination" is sometimes employed to mean fertilization, while "conception" is of still more uncertain significance, since it is sometimes used synonymously with coitus and with implantation as well as with fertilization.

In all mammals the egg is fertilized in the upper portion or ampulla of the uterine tube. Sperms must be waiting for the egg, since this remains intact and fertilizable but a short while after its extrusion from the ovary. In the rabbit as well as the rat and the mouse the eggs may be seen through the thin wall of the ampulla and when removed are often to be found surrounded

take place also in the mammalian egg, for polyspermy is extremely rare in them.

Only the "head" of the sperm usually enters the egg, though the tail occasionally follows (Fig. 165). It is the head of the sperm and the "neck" that are the really important parts of the sperm. After they enter the cytoplasm of the egg their subsequent behavior reveals their identity. The head gradually approaches the female nucleus and at the same time becomes larger and spherical and soon takes on the typical vesicular appearance of a nucleus. The neck-piece brings in the centrosome (Fig. 164, B), which soon divides in two, the resulting pair of centrosomes taking their respective places preparatory to effecting the first cleavage division (Fig. 164, C). The sperm head has become the male pronucleus. At this stage it is seen that the sperm head was nothing but a very condensed nucleus, the cytoplasm being reduced to a thin sheath and the tail.

The entrance of the sperm into the mammalian egg constitutes the impulse for certain changes in the female nucleus. The second polar body is given off (Fig. 165, A). The chromosomes remaining in the egg then disappear as such and a vesicular nucleus similar to the male pronucleus is formed and is now known as the female pronucleus. The two pronuclei approach each other (Fig. 165, B) and merge into a single nucleus, and fertilization is completed. In some lower animals the chromosomes of the sperm and of the egg approach and arrange themselves at once on the first cleavage spindle. The result is the same as though there were a vesicular stage in between as in mammals. Each pronucleus contributes its half of the chromosome complex and the resulting fused nucleus contains the full or diploid number of chromosomes characteristic of the species. As the fertilized egg owes half of its chromosomes to the paternal and half to the maternal parent, so will every cell of the body arising from the fertilized egg cell.

With the fertilized egg a new being is launched into the world. His body is the result of repeated cell multiplication and differentiation, as will be set forth in the next chapter.

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CHAPTER XIII

THE EARLY DEVELOPMENT OF THE EMBRYO

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CLEAVAGE

Fertilization precipitates in the ovum a series of cell divisions which follow one another in close succession. The way in which these so-called *cleavage divisions* are carried out varies in different groups of animals in correlation with the amount of yolk stored in the ovum as food material for its growth needs. The yolk, being nonliving and inert, plays no active part in cleavage, which must be carried out by the living protoplasmic portion of the cell, but it does exert a local retarding effect by the mechanical impediment it offers to the process. Consequently, in such eggs as those of amphibians or birds where the yolk content is large, its presence complicates the pattern assumed by the daughter cells during cleavage. In the ova of all the higher mammals the amount of stored food material is exceedingly small, correlated with the fact that the embryo at an early stage in its development draws upon the uterine circulation of the mother for its nutrition. For this reason the cleavage of mammalian ova reverts to the simple type seen in very primitive forms having ova with a scanty and uniformly distributed yolk content.

Although the cleavage stages of the human ovum have not as yet been observed there is every reason to believe that they differ in no essential from the corresponding stages in other mammals with similarly organized ova. In fact, in all the higher mammals so far studied, the cleavage pattern is strikingly similar. The cleavage divisions in the monkey ovum, recently studied in great detail in living eggs reared by tissue culture methods, probably parallel very closely the corresponding stages in man and have, therefore, been used to fill this gap in our direct knowledge of the earliest steps in human development.

In dealing with a spheroidal cell such as an ovum some criterion of orientation is most helpful. Ova which have a large amount of yolk aggregated at one pole offer no difficulty in this respect. The pole at which the yolk is concentrated may be designated as the *vegetative pole*, and the opposite pole, where the nucleus and most of the unmodified cytoplasm lie, may be called the *animal pole*. No such clearly marked polarity exists in the ova of the higher mammals because the stored food material is minimal and fairly uniformly distributed as minute lipoid droplets in the cytoplasm. The point at which the polar bodies are liberated is, however, probably homologous with the so-called "animal pole" of heavily yolked eggs, and may be used to serve as an orientation point in discussing the planes of the early cleavage divisions.

In mammals, as is the case with surprising uniformity throughout the animal kingdom, the mitotic spindle of the first cleavage division forms at

right angles to an imaginary axis passing through the ovum from animal to vegetative pole (Fig. 154, page [illegible]). The plane of separation between the resulting blastomeres, as the daughter cells are called, lies in the equator of the spindle, and therefore coincides with the imaginary axis of the ovum as established by the point at which the polar bodies were liberated (Fig. 157, A).

Minute spindles for the second cleavage divisions are formed in the first two blastomeres shortly after their establishment. One of the blastomeres usually divides a little sooner than its mate so there is a transitory three-cell stage (Fig. 157, B) before the characteristic four-cell stage is reached. The spindles for these second divisions form at right angles to the first and to each other, so that the characteristic four-cell stage has the configuration of crossed dumbbells (Fig. 157, [illegible]).

Further cleavage divisions follow one another in an orderly series, but in less precise orientation. So rapid is their succession that the growth interval which ordinarily supervenes between succeeding mitoses is curtailed. In consequence, there is at first no growth in the cell mass as a whole and the individual blastomeres after each succeeding division become smaller and smaller (Fig. 157, [illegible]). Since the zona pellucida persists intact throughout the period of cleavage, the blastomeres are forced to dispose themselves within its spheroidal cavity. After several cleavage divisions have taken place, the resultant group of blastomeres appears much like a solid ball of cells suggestive of a mulberry. The embryo in this condition is said to be in the morula (L., "little mulberry") stage (Fig. 158, A).

THE DIFFERENTIATION OF THE BLASTODERMIC VESICLE

After a characteristic morula has been formed, the term "cleavage" is not ordinarily applied to the cell divisions which occur. The implication should not be drawn that cell division ceases or even that it is retarded in rate. On the contrary it continues with unabated rapidity. But processes of segregation and differentiation even thus early begin to make their appearance and the term "cleavage," which implies merely an increase in cell numbers through repeated cell divisions, ceases adequately to characterize the processes of regrouping and divergent specialization which now begin to make their appearance. While each cell division seems to pass on to each daughter cell a scrupulously divided share of the chromatin which was the dowry of the fertilized ovum from the parents, subtle sorting out processes are already at work. "To say that the daughter cells make an uneven division of their heritage is, of course, a crude way to state it. To say anything more precise at the present time would be highly speculative" (Streeter, 1931, p. [illegible]). But as we trace development beyond the cleavage stages the regrouping of specialized cell masses which unfold into definite organs testifies to the existence of a sorting out process we cannot as yet analyze.

When the blastomeres of a morula begin to be rearranged and organized about a central cavity (Fig. 158, B–E) we say that the morula is becoming a blastula or that the embryo is entering the blastodermic vesicle stage. It is during this phase of development that the restraining zona pellucida disintegrates and the rapid growth of the embryo in size first begins. The newly formed central cavity is called the segmentation cavity or blastocoele (Fig. 158, E, and Fig. 159, [illegible]). The large size of the blastocoele in mammalian embryos of this age has a dual significance. Phylogenetically, this cav-

fluid-filled space represents the place where ancestral types carried a dowry of food in the form of yolk. Ontogenetically, as we so often see in embryology, the outgrown plan persists and is adapted to new conditions. The yolk

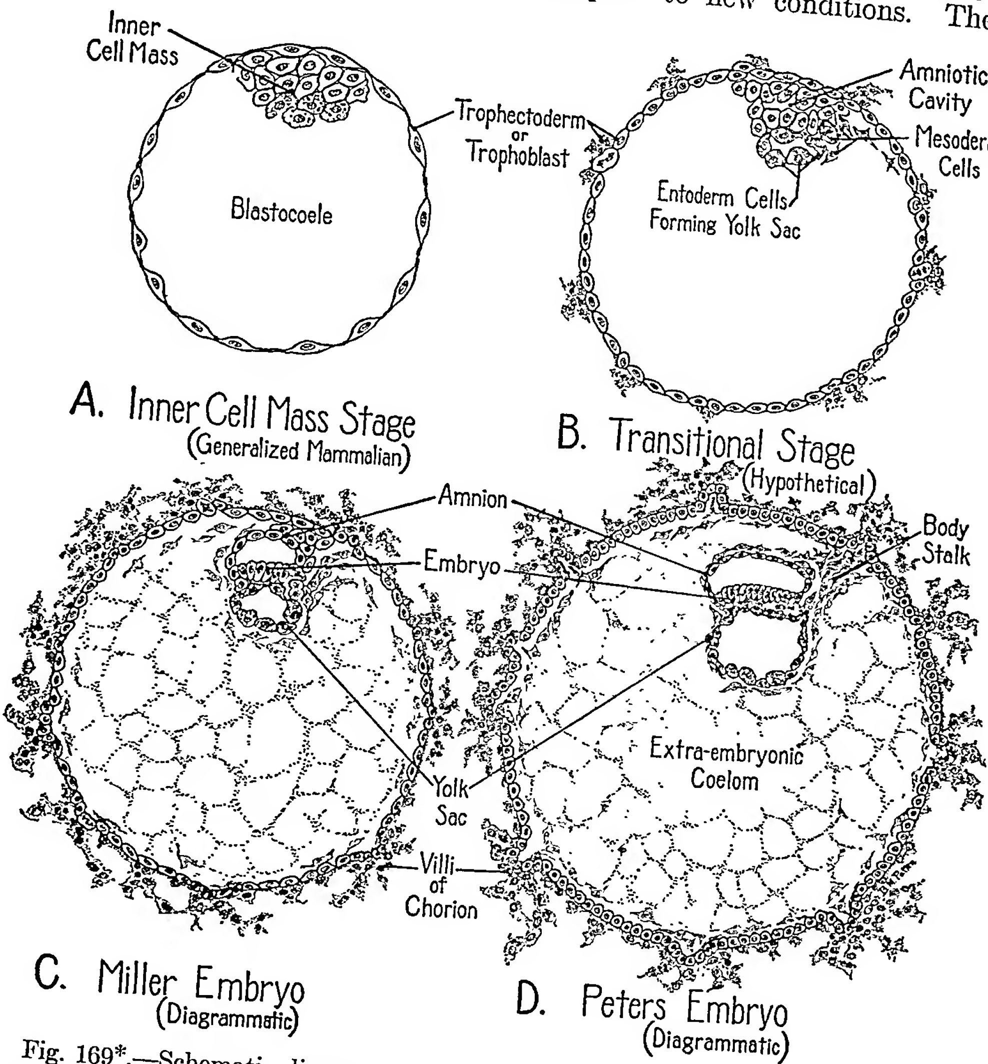

Fig. 169*.—Schematic diagrams indicating the probable manner in which the structural plan exhibited by the youngest known human embryos is derived. A, Generalized scheme of mammalian blastodermic vesicle. There is no reason to believe that the human embryo, if secured about a week after fertilization, would show any essential differences from this plan which is common to all the higher mammals as yet critically studied. (*Cf.* Fig. 168, *D.*) B, Hypothetical transitional stage. Probable condition of human embryo about eight or nine days after fertilization. C, The youngest well-preserved human embryo, schematically represented. (*Cf.* Fig. 170, an actual photomicrograph of this same Miller embryo which has a probable fertilization age of ten to eleven days.) D, Schematization of the Peter's embryo, probable fertilization age of about twelve to thirteen days. The capacious extra-embryonic celom is already completely lined by mesodermal cells (shown in red) and contains a granular material called the magma reticulare. This "magma" is probably the result of the coagulation during fixation of a protein-containing fluid which filled the exocelom during life. The scattered cells frequently seen in the magma may be regarded as migratory mesoderm cells which had not at the moment of fixation found their place in the exocelomic lining.

* This figure and Figures 171, 174–180, 185, 186 and 188–191, from a forthcoming book by Dr. Patten are reproduced with the permission of P. Blakiston's Son and Co.

fertilization, and on the twenty-second or twenty-third day of the mother's menstrual cycle, when the uterine mucosa was entering on its phase of congestion preceding the next expected period, the rapidly growing trophoblast began to invade the uterine mucosa. In another day the growing villi had

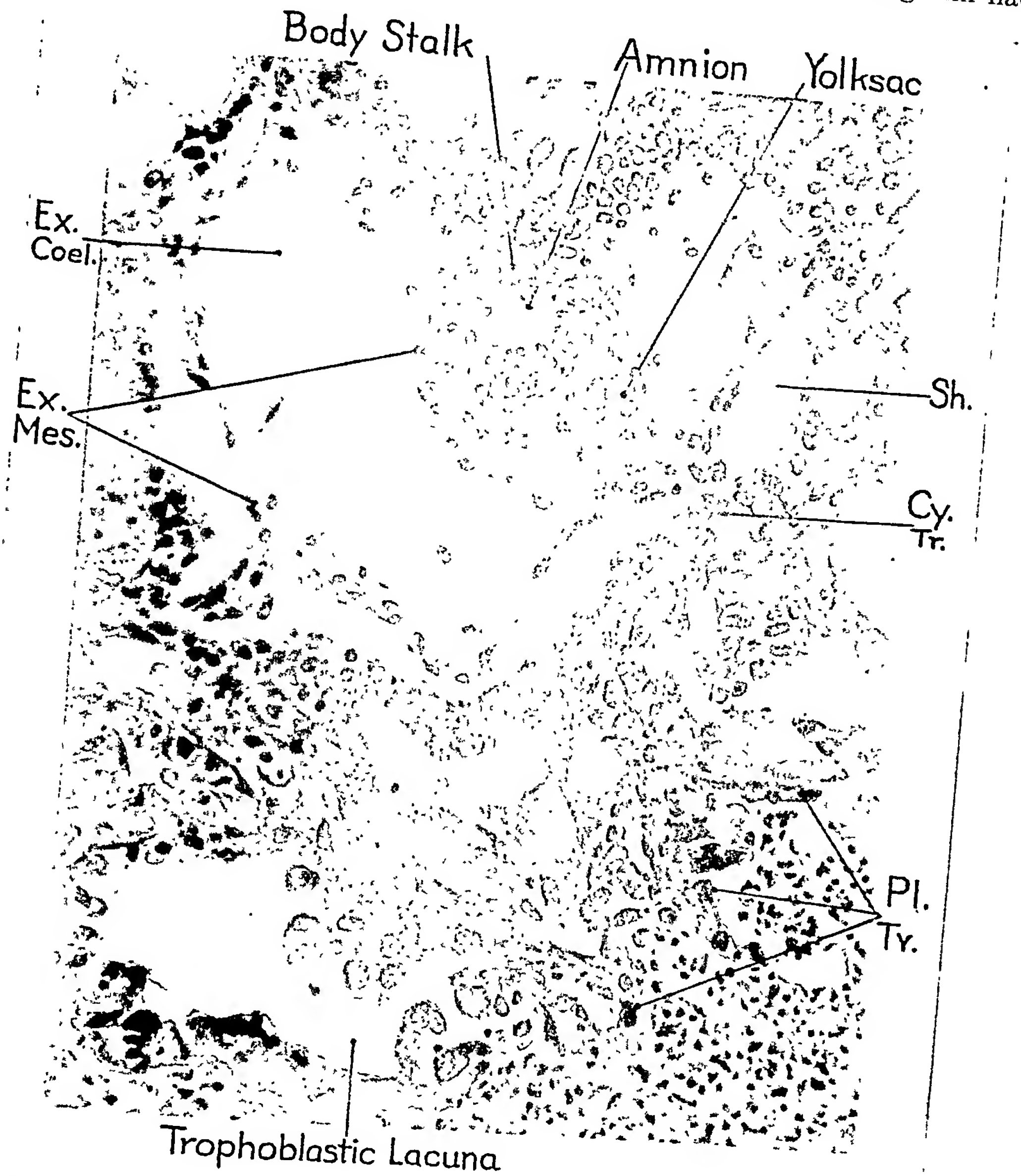

Fig. 170.—Human embryo of about ten days' fertilization age. Photomicrograph (× 200) of a section of the Miller embryo. Compare with Fig. 169, C. Abbreviations: Cy. Tr., Cytotrophoblast; Ex. Coel., extra-embryonic celom; Ex. Mes., extra-embryonic mesoderm; Pl. Tr., plasmodiotrophoblast; Sh., space between extra-embryonic mesoderm and trophoblast due to shrinkage in fixation. (After Streeter, Carnegie Cont. to Emb., 1926, vol. 18.)

burrowed into the endometrium and just as the embryo was well embedded it was rudely removed by curettage and, fortunately, recognized and preserved (Fig. 170).

morphological localization of a cell group which we readily recognize as the primordium of a definite organ. For example, although the chick's optic vesicle does not appear as a definite primordium until after thirty hours of incubation, if a narrow transverse strip of the ectoderm of a twelve-hour

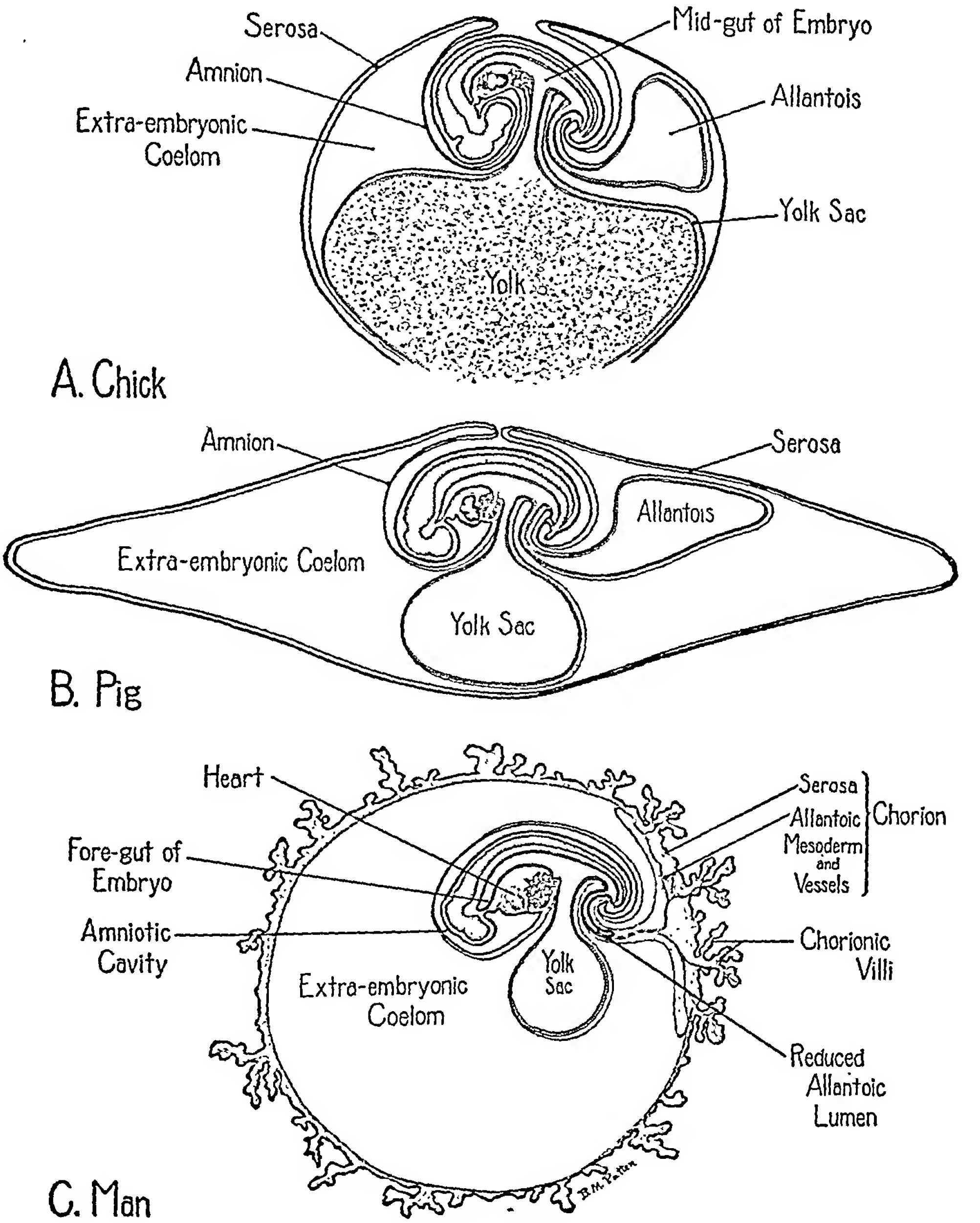

Fig. 171.—Diagrams showing the interrelations of embryo and extra-embryonic membranes characteristic of higher vertebrates. Neither the absence of yolk from its yolk sac, nor the reduction of its allantoic lumen radically changes the human embryo's basic architectural scheme from that of more primitive types.

embryo is cut out from the region either side of Hensen's node and grown by tissue culture methods, it will in due time, show specialized cellular elements of types which occur only in the eye. A strip taken from another region,

cate the surprisingly early stage at which there is, within the germ layers, invisible localization of cells with different developmental potentialities. As development progresses these localized cell groups are bodily and visibly sorted out. In some cases their sorting out is accomplished by a folding off from the parent germ layer, in other cases by migration of individual cells which later become reaggregated elsewhere. From primordial cell groups thus derived the organs with which we are familiar in the adult gradually take shape. The study of the embryological origin of the various parts of the body is, therefore, the history of the growth, subdivision, and differentiation of the germ layers (Fig. 172).

THE ESTABLISHING OF THE BODY

The formation of the body is initiated by the same growth processes which establish the germ layers. But even after the germ layers have been laid down and have begun to show considerable differentiation the configuration of the young embryo is so unlike that of the adult that, except to one familiar with embryology, there are no readily identified landmarks. There is no distinct head, no neck, no trunk; there are no appendages; in short, there are none of the conspicuous structural features by which we are accustomed to orient ourselves in dealing with adult anatomy.

In the Miller embryo the *embryonic disc*, which is all there is in the way of a body, lies between the rudimentary yolk sac and the amniotic cavity. It consists of a layer of a few ectodermal cells, a few entodermal cells, and the beginnings of a cluster of mesodermal cells (Figs. 169, C, and 170).

In the well-known Peter's embryo (Fig. 169, D) which is perhaps a day or two older than the Miller embryo, the embryonic disc has become larger and more clearly defined, but still shows no definite landmarks. It is about two weeks after fertilization, when the primitive streak makes its appearance, that the longitudinal axis of the body is first clearly defined (Fig. 173). To the comparative embryologist the *primitive streak* is of especial significance because it represents the lips of the blastopore of premammalian ancestors pulled into an axial scar by concrescent growth. To one interested primarily in mammalian development the chief significance of the primitive streak is its activity as a growth center. From it cells push forth into one or another of the germ layers, which there take common origin (Fig. 173, *D*). The *notochord*, also, arises as a column of cells pushed forward in the midline from a proliferation center, called *Hensen's node*, at the anterior end of the primitive streak (Fig. 173, *B*). But in spite of the very rapid cell division which can be seen to occur in it, the primitive streak does not increase in size. Nor does it move cephalad in the growing body. It becomes, on the contrary, a relatively less and less conspicuous structure and retains its original caudal position (*cf.* Figs. 173, *B*, and 174, B). The reason for this is the fact that the cells proliferated in the primitive streak region do not remain there, but push forth as fast as they are formed. The great bulk of the new cells are crowded in between the primitive streak and the already established part of the embryo cephalic to the streak. This results in rapid expansion of the body anterior to the primitive streak. One is very likely, in observing a series of embryos in which the progress of elongation in the anterior region is so striking, to attribute it entirely to especially active growth in this

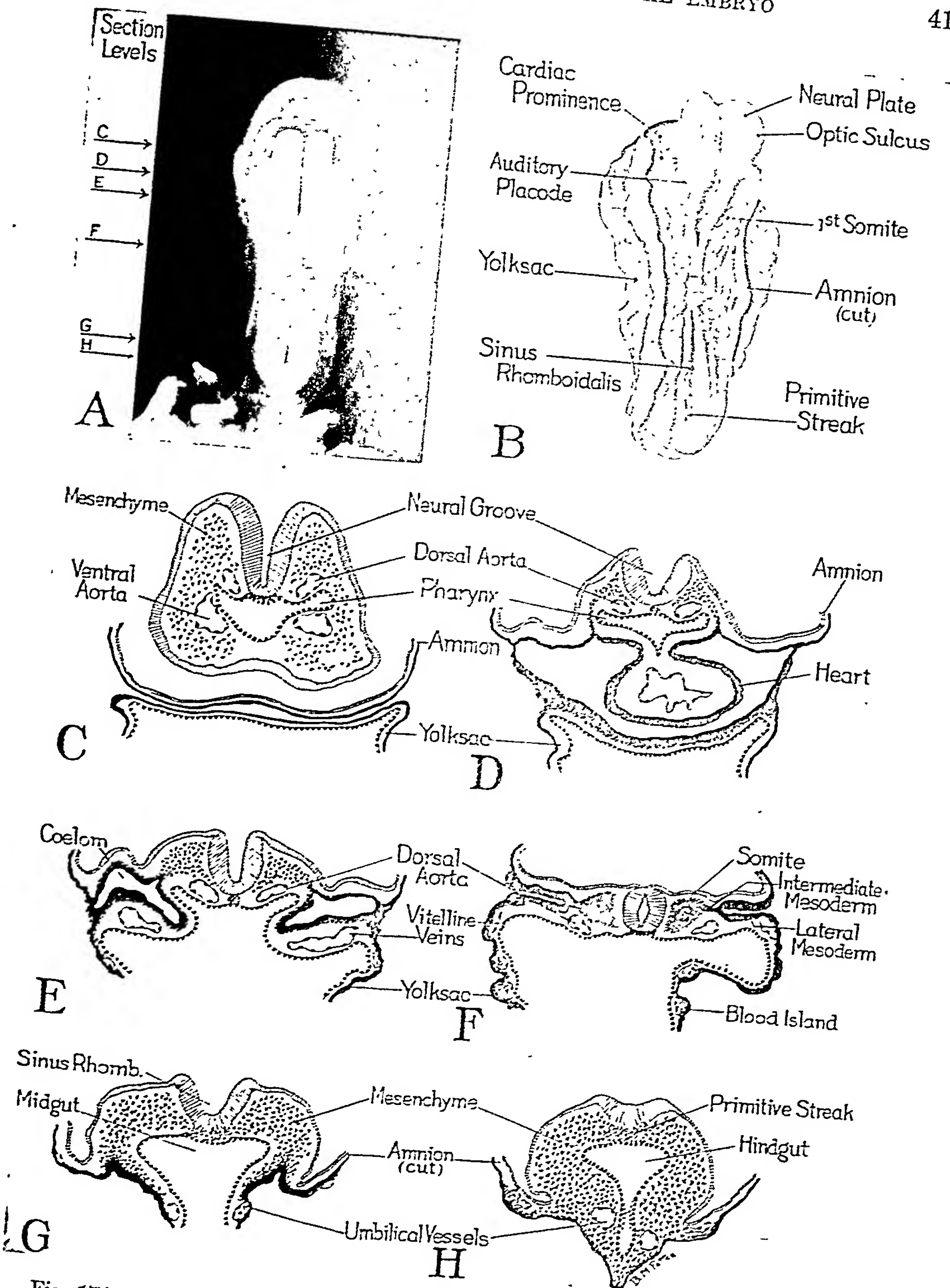

Fig. 174.—Structure of human embryo in the seven- to eight-somite stage—probable fertilization age of eighteen to nineteen days. A, The Bartelmez eight-somite embryo (University of Chicago, H 1404) photographed (× 12½) before sectioning. B, Reconstruction of the Payne seven-somite embryo (× 22). C to H, Sections of the Bartelmez embryo at the levels indicated in A, projection outlines (× 60), schematically represented with ectoderm hatched; entoderm, a beaded line; mesenchyme, angular stippling; and the more solid parts of the mesoderm in black.

THE EARLY DIFFERENTIATION OF THE CEPHALIC REGION

From the standpoint of comparative anatomy and embryology the developing head is divisible into a *neurocranial* portion and a *visceral* portion. The neurocranial portion includes, together with their supporting structures, the brain, the eyes, the internal ears, and the nervous part of the olfactory organs. The visceral portion includes the cephalic termination of the digestive-respiratory tract and the associated facial structures which are developed for the most part from the primitive gill arch complex of water-living ancestral

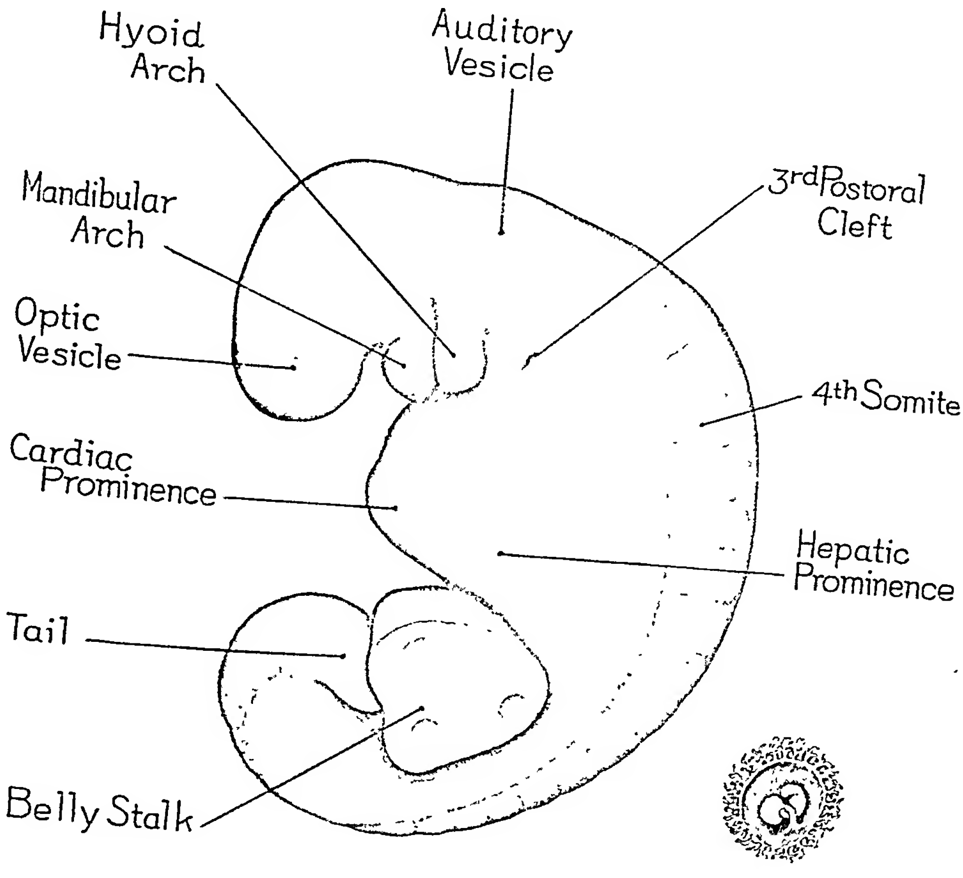

Fig. 177.—Human embryo about thirty days after fertilization. Retouched photograph (× 20) of embryo No. 5923 in the Carnegie collection; C. R. (*i. e.*, crown-rump length). 3.9 mm.; 30 pairs of somites. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

types. These two regions differ as to their rates of growth and differentiation. The neurocranial portion is precocious, being very conspicuous in young embryos. While its early predominance is never completely lost it is greatly reduced in fetal and early postnatal life by the growth of the facial structures which is relatively more rapid in these later phases of development (Fig. 185).

In very young embryos the topography of the head is but vaguely defined. It soon, however, becomes more precisely marked out by the appearance of

The cephalic region of an embryo of but three weeks' fertilization age is, therefore, already indicated by this anterior enlargement of the neural plate.

Toward the end of the third or beginning of the fourth week the primordia of both the ear and the eye become recognizable. The inner ear mechanism first appears as a pair of depressed placodes in the superficial ectoderm at the level of the more posterior part of the brain (Fig. 175, B). These primordial

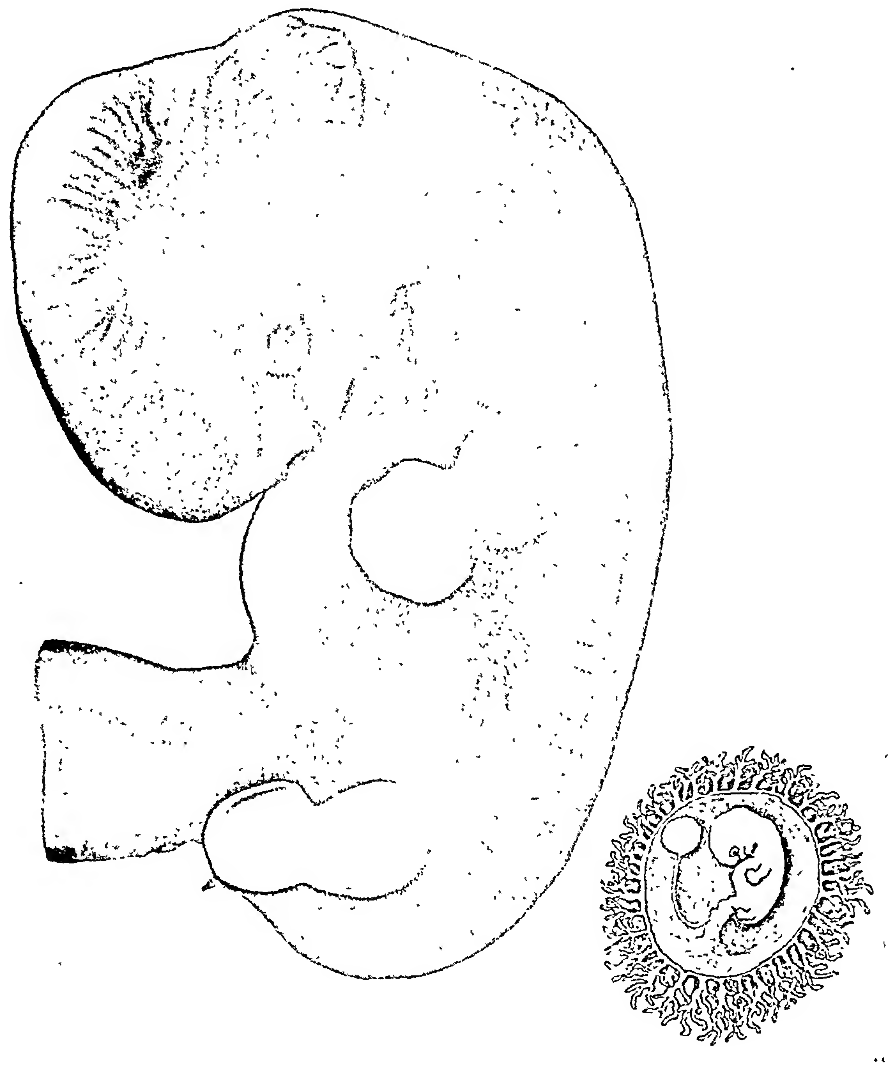

Fig. 179.—Human embryo of about six weeks' fertilization age. Retouched photograph (× 8) of embryo No. 1267A in the Carnegie collection; C. R., 14 mm. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

cell clusters soon sink below the surface to form the auditory vesicles (Fig. 185, B) and cease to be prominent externally (Fig. 178).

The eyes arise as local outgrowths from the lateral walls of the anterior part of the brain (Fig. 185). Long before the *optic vesicles*, as the early outgrowths are called, bear any resemblance to adult eyes, their position can be seen because of the prominence they make in the overlying ectoderm (Figs.

stomodeum are the elevations which surround the nasal pits, and the paired maxillary processes which are destined to form the lateral parts of the upper jaw (Fig. 178). Phylogenetically these structures are exceedingly ancient, being traceable to preoral arches in the invertebrate stock (arachnids) from which the vertebrates were derived.

Caudal to the oral depression is a series of paired elevations with clefts between them. These structures are clearly homologous with the gill arches and clefts of fishes and amphibians. The most anterior of these arches lies immediately caudal to the primitive mouth opening (Figs. 176 and 188). Because it is involved in the formation of the lower jaw, it is called the *mandibular arch*. Next behind the mandibular is the *hyoid arch*. The arches behind the hyoid, being unnamed, are referred to by numbers as postoral arches three, four, and five (rudimentary). As development progresses the arches posterior to the mandibular arch become less conspicuous and are incorporated into the neck (Figs. 178–180), their deeper tissues giving rise to such characteristically located structures as the hyoid bones and the thyroid cartilages (Fig. 185).

The first cleft, that is, the cleft between the mandibular and hyoid arches, is retained in part and becomes differentiated into the middle ear and eustachian tube. In embryos of about six weeks nodular masses of rapidly growing tissue appear about the external part of this cleft initiating the formation of the external ear (Fig. 179).

The more posterior clefts are, in the normal course of development, obliterated externally, but occasionally one of them may persist, giving rise to the anomaly known as a *cervical fistula*.

EARLY DIFFERENTIATION IN THE TRUNK REGION

Like their remote invertebrate forebears, all vertebrates have a segmentally organized body. In adult mammals the underlying metamerism is largely masked by local fusions and superimposed specializations. But even so, unmistakable evidences of this fundamental plan of structure persist in the segmentally arranged spinal nerves and ganglia, in the vertebrae, and in the arrangement of the ribs and of the intercostal musculature. In the young embryo metamerism is much more obvious. One of its most conspicuous superficial markings is the series of paired prominences which indicate the location of blocklike masses of mesoderm called *somites* (Figs. 176–179). These aggregations of mesodermal tissue are clearly metameric in arrangement. In fact, it is through them that we trace the origin of the segmental arrangement of the axial skeleton and the thoracic musculature just alluded to as one of the characteristic evidences of metamerism in adult anatomy. The origin and relations of the somites will be returned to later. At the moment it is sufficient to note their metameric arrangement in the young embryo.

The external prominence made by the developing heart appears at a strikingly early stage. The heart at first lies far toward the head as compared with its definitive position. Bearing in mind that the mandibular arch will form the lower jaw, we can say that the heart originates "under the chin" (Fig. 176). As growth proceeds there is rapid elongation of the embryo between its head and trunk, which results in the establishment of the cervical region. In this process the heart is carried caudad to lie in its characteristic

fore, quite prepared for the manner in which the primitive streak, when it has taken definite shape, continues to be an active growth center from which new cells are pushed forth into the expanding sheet of mesoderm (Figs. 173, *D*, and 174, H).

The mesoderm is by no means limited to an *intra-embryonic* distribution, but extends well beyond the boundaries of the body. We may distinguish that part of the mesoderm which extends peripherally to line the blastodermic vesicle and to reinforce the amnion and the yolk sac as *extra-embryonic* (Fig. 169). These peripheral layers of the mesoderm, together with the trophoblast, the amniotic ectoderm, and the yolk-sac entoderm, go into the fabrication of protective and trophic membranes, which envelop the growing embryo (Fig. 171). The fact that they are not incorporated in the embryonic body, but discarded at the time of birth, is implied in their designation as extra-embryonic membranes.

Within the midbody region of the embryo the mesoderm on either side of the notochord becomes markedly thickened (Fig. 181, A). These paired thickened zones from which the somites are formed constitute the so-called *dorsal mesoderm.* Extending to either side from the zones of thickened dorsal mesoderm are the sheets of *lateral mesoderm* which start intra-embryonically and extend beyond the confines of the body as extra-embryonic mesoderm. Between dorsal and lateral mesoderm is a narrow junctional zone known as the *intermediate mesoderm* (Fig. 181, A). The more anterior parts of the intermediate mesoderm give rise to the transitory urinary organs of early embryonic life, the *pronephros* and the *mesonephros.* Its more caudal regions later become involved in the formation of the permanent kidney or *metanephros.*

It should be emphasized that the clearcut differentiation of the mesoderm into the zones described above is characteristic only of the midbody region (Fig. 174, F). Both cephalically and caudally the mesoderm is at first represented by unorganized masses of sprawling, actively migrating cells designated collectively as *mesenchyme.*

Very early in development the lateral mesoderm becomes organized into two layers. The outer layer is called the *somatic mesoderm* and the inner layer the *splanchnic mesoderm* (Fig. 181, B). The cavity between somatic and splanchnic mesoderm is the *embryonic body cavity* or *coelom.* Because the somatic mesoderm and the ectoderm are closely associated and undergo many foldings in common, it is frequently convenient to designate the two layers together by the term *somatopleure.* For the same reasons splanchnic mesoderm and entoderm together are designated as *splanchnopleure* (Fig. 187, A and B).

This differentiation of the mesoderm into somatic and splanchnic layers is first clearly marked extra-embryonically, but as development progresses, the originally solid lateral mesoderm within the embryonic body also becomes split into somatic and splanchnic layers. Thus an intra-embryonic portion of the coelom is established which is directly continuous with the previously formed exocoelom (Fig. 187). Later in development, as the growing embryo is more definitely separated from its surrounding membranes, we see a demarcation between intra- and extra-embryonic coelom quite sharply established. The part of the coelom then included within the embryo gives rise to its pericardial, pleural, and peritoneal cavities.

tensive growth of the extra-embryonic layers which foreshadows their prompt differentiation into trophic membranes. Both these phenomena would seem to be quite definitely correlated with the paucity of yolk in the mammalian ovum. In the absence of a readily available supply of stored food material, membranes capable of establishing metabolic interchange with the maternal circulation, and a fetal circulation capable of transporting and distributing

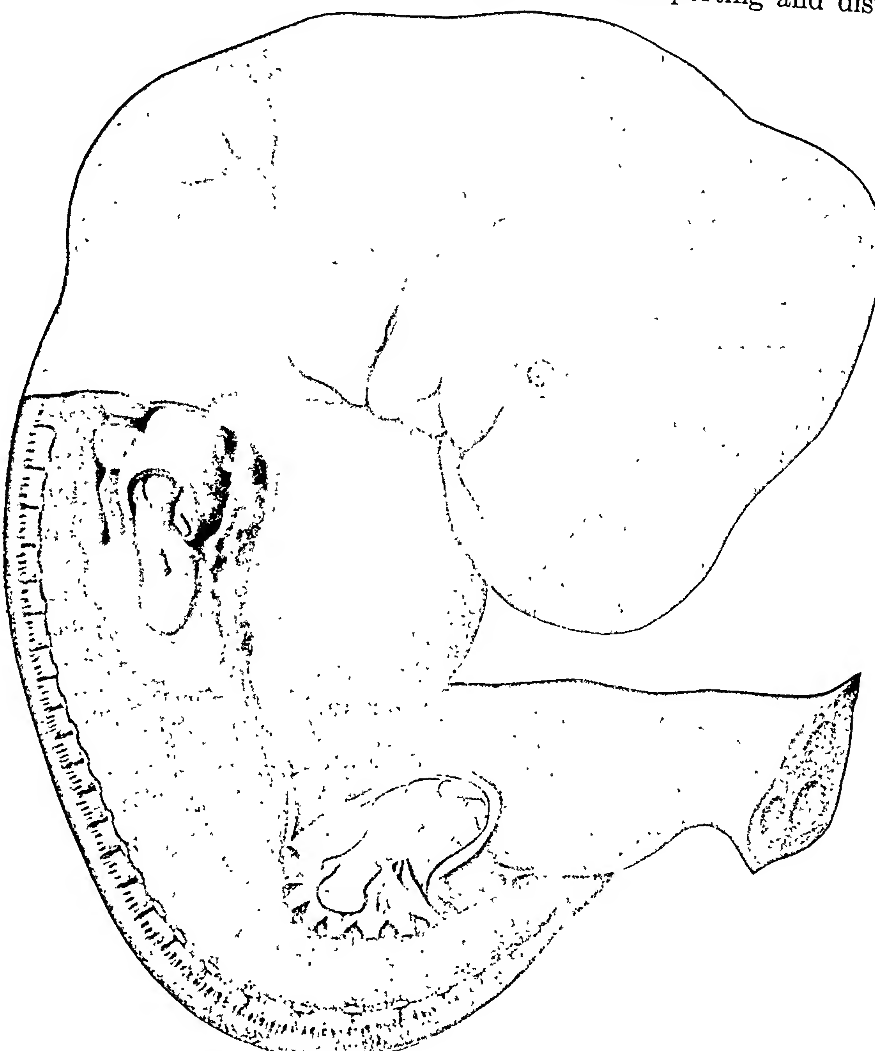

Fig. 182.—Reconstruction (× 13) of a 9-mm. human embryo to show the partially fused myotomes and the premuscle masses of the limbs. Distally, in the upper extremity, the radius, ulna, and hand plate are disclosed; in the lower extremity the hip bone and the border vein show. (After Bardeen and Lewis, Amer. Jour. Anat., 1901, vol. 1.)

the food material absorbed through these membranes, are equally indispensable for the growth of the embryo.

The earliest manifestations of metamerism to appear in the body of the mammalian embryo are the blocklike, radially arranged cell masses, the *mesodermic somites*, which are derived from the dorsal mesoderm. In human embryos the first pair of somites appears in the midbody region about the sixteenth day after fertilization. As continued growth from the primitive

181, D). These cells become concentrated about the neural tube and notochord, eventually giving rise to the vertebrae.

THE ESTABLISHING OF THE ORGAN SYSTEMS

It is neither practical nor desirable in a brief chapter such as this to enter into the details of the processes whereby the various organ systems are gradually molded into their adult configuration. For such information reference must be made to some of the many available text and reference books on embryology. It is, however, possible to sketch in broad outlines some of the major processes involved in the establishing of the organ systems. With the general nature and trend of these early processes as a foundation, it becomes a matter of little difficulty for one as familiar with the structure of the adult body as is the physician, to acquire detailed information concerning any of the special phases of development which, from time to time, obtrude themselves in his practice.

The Nervous System

In dealing with the differentiation of the cephalic region, mention was made of a thickened area of the ectoderm called the *neural plate.* The first step in the formation of the central nervous system from this primordial mass of cells is its transformation from a superficial plate into a tubular

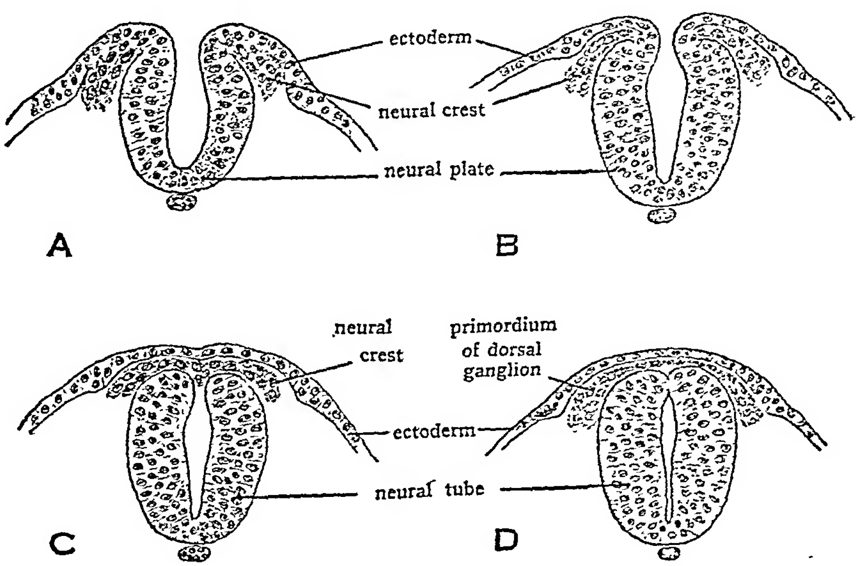

Fig. 183.—Drawing (× 135) showing closure of the neural tube and formation of the neural crest. From pig embryos of: A, Eight somites. B, Ten somites. C, Eleven somites. D, Thirteen somites. (From Patten, "Embryology of the Pig," P. Blakiston's Son and Co.)

structure lying beneath the ectoderm. As is the case with so many early embryological phenomena, this is brought about by a process which can most conveniently be described as folding. Due to differential growth the neural plate becomes depressed centrally and elevated laterally, thus establishing the *neural groove* (Figs. 174 and 181, A). Continuation of this same process soon closes the groove into a tube. When the margins of the neural plate

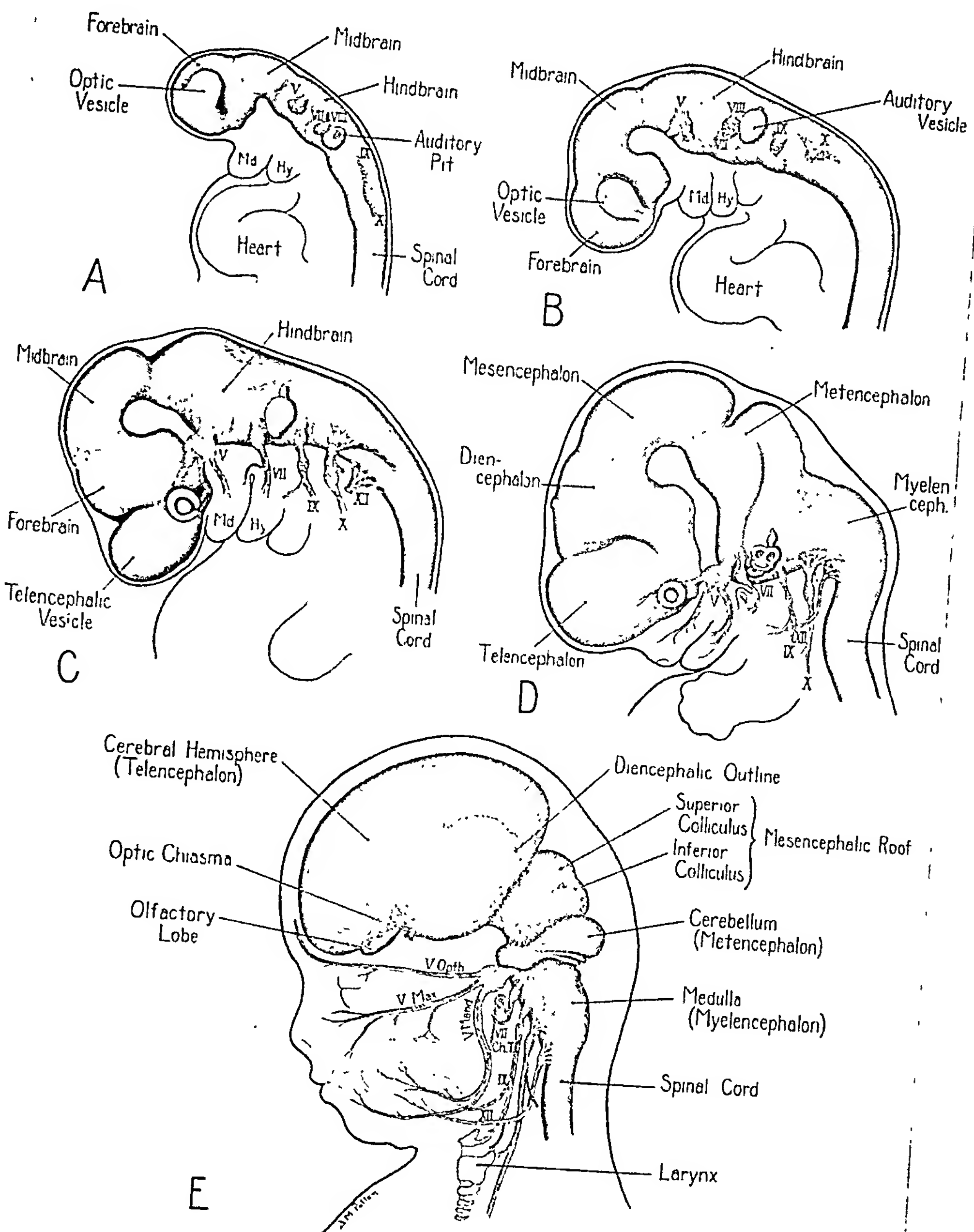

Fig. 185.—Five stages in the early development of the brain and cranial nerves. (Adapted from various sources, primarily figures by Streeter and reconstructions in the Carnegie collection.) A, At twenty somites—based on the Davis embryo—probable fertilization age of three and a half weeks. B, At 4 mm., fertilization age of about four weeks. C, At 8 mm., fertilization age of about five and a third weeks. D, At 17 mm., fertilization age of about seven weeks. E, At 50 to 60 mm., fertilization age of about twelve weeks. The cranial nerves shown are indicated by the appropriate Roman numerals: V, Trigeminal; VII, facial; VIII, acoustic; IX, glossopharyngeal; X, vagus; XI, accessory; XII, hypoglossal. Abbreviations: Ch.T., Chorda tympani branch of seventh nerve; Hy., hyoid arch; Md., mandibular arch; V Mand., mandibular branch of the trigeminal nerve; V Max., maxillary branch; V Opth., ophthalmic branch.

sinus rhomboidalis (Fig. 174, B). It is to retardation or distortion of the processes which normally close this sinus rhomboidalis early in the second month of development, that the various types of spina bifida are due.

The Digestive System

Even before the body of the embryo takes shape, the formation of the digestive system has been initiated by the establishment of the entodermal layer within the spheroidal blastocyst (Fig. 169). When the mesoderm has been formed and split into somatic and splanchnic layers, the splanchnic mesoderm becomes closely associated with the entoderm, the two layers together being known as the *splanchnopleure.* Thus the primitive gut, very early in development, acquires a double-layered wall (Figs. 173 and 174). The entodermal component of the splanchnopleure gives rise to the epithelial lining of the gut tract and to its glands. The associated layer of splanchnic mesoderm becomes differentiated into the muscular and connective tissue layers of the gut wall.

By the time the wall of the primitive gut has received its mesodermal reinforcement, the embryonic body begins to be bounded by definite folds. These body folds increase in depth and undercut the embryo, separating it, except for the communicating belly stalk, from extra-embryonic structures. At the same time they play an important part in determining the configuration and relations of the gut tract within the embryo. This folding-off process begins with a ventral bending of the margins of the embryonic area so that the developing body takes on a marked dorsal convexity. Then the undercutting of these depressed margins cephalically and caudally, together with rapid increase in the length of the embryonic body, cause the embryo to overhang the extra-embryonic layers (Fig. 186). Coincidently the downfoldings on either side of the embryo become more definite, emphasizing its lateral boundaries (Fig. 187, B and C). The progressive deepening of all these circumscribing folds and the continued growth of the body itself constricts the connection of the embryo with the extra-embryonic membranes, initiates the formation of the belly stalk, and at the same time establishes the lateral and ventral body walls of the embryo (Figs. 186 and 187).

The superficial foldings which thus establish the boundaries between the embryonic body and extra-embryonic portions of the germ layers have their counterparts in the deeper lying layers. The changes which take place in the configuration of the splanchnopleure during this process bring about the division of the primitive gut into an intra-embryonic portion and an extra-embryonic portion known as the *yolk sac.*

The first part of the primitive gut to be incorporated definitely within the body of the embryo is that portion lying beneath the head. With the forward growth of the head and its concomitant undercutting by the subcephalic fold, an entodermally lined pocket is established in the cephalic region. This is the *foregut* (Fig. 186, B). Posteriorly the foregut remains in open communication with the rest of the primitive gut cavity by way of the anterior intestinal portal (Fig. 186, B).

In a similar manner a pocket known as the *hindgut* is formed beneath the caudal portion of the embryo. Anteriorly the hindgut retains open communication with the rest of the primitive gut cavity by way of the posterior intestinal portal (Fig. 186, B).

Beneath the body of the embryo, between foregut and hindgut, is a region of the primitive gut which is destined to be included within the body, but which as yet has no floor. This region is known as the *midgut*. As the embryo is constricted off from the extra-embryonic layers by the progress of the subcephalic and subcaudal folds, the foregut and hindgut are increased

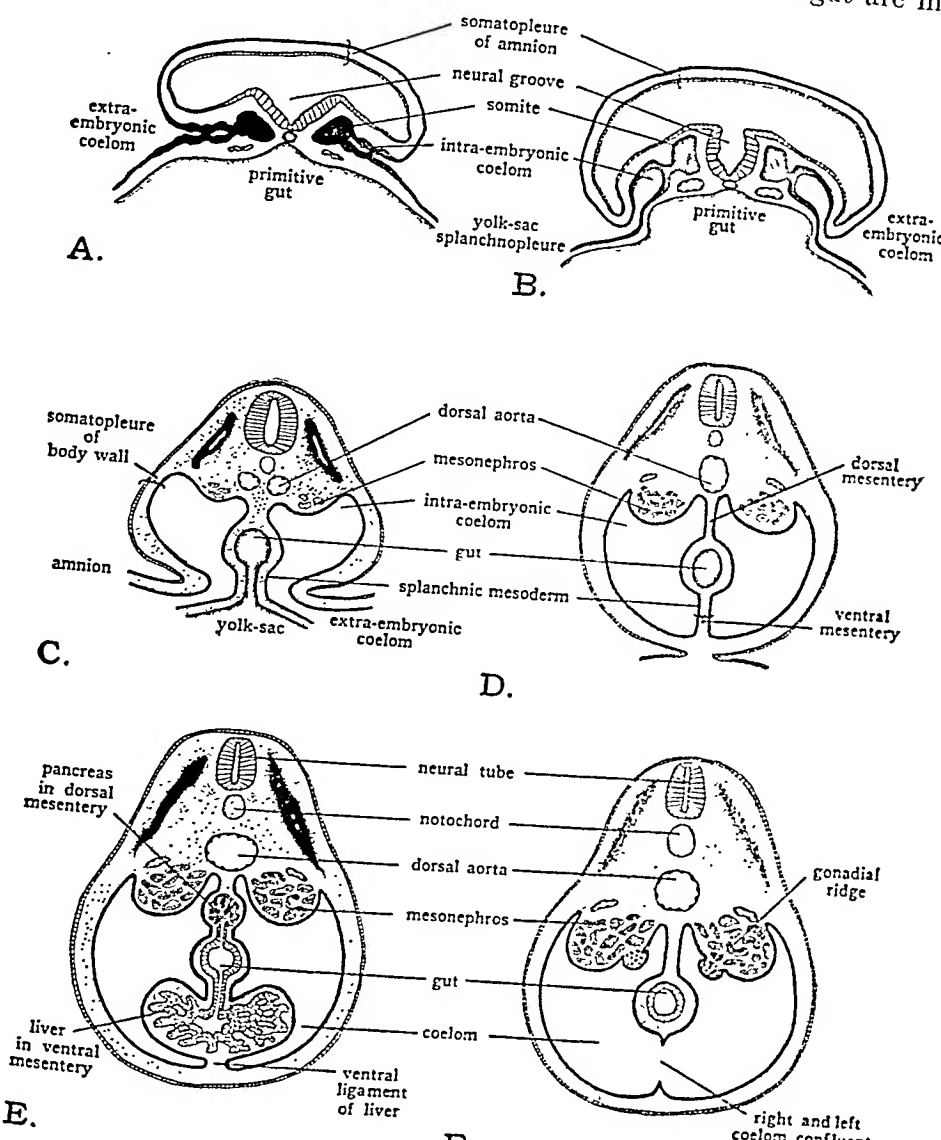

Fig. 187.—Schematic transverse sections showing the closing off of embryonic gut from primitive gut, the separation of intra- from extra-embryonic celom and the development of the primary mesenteries. (Compare with Fig. 186.) (From Patten, "Embryology of the Pig," P. Blakiston's Son and Co.)

in extent at the expense of the midgut. The midgut is finally diminished until it opens to the yolk sac only by the restricted canal of the yolk stalk (Fig. 186, D).

When first separated from the yolk sac, the embryonic gut ends blindly both cephalically and caudally, with no indications of either oral or anal

precocious development of the vascular system of the embryo, for the maternal circulation remains confined within the uterine walls, and the embryonic circulation must grow to it. Until this is accomplished the embryo is dependent on what food material it can obtain by direct absorption from the

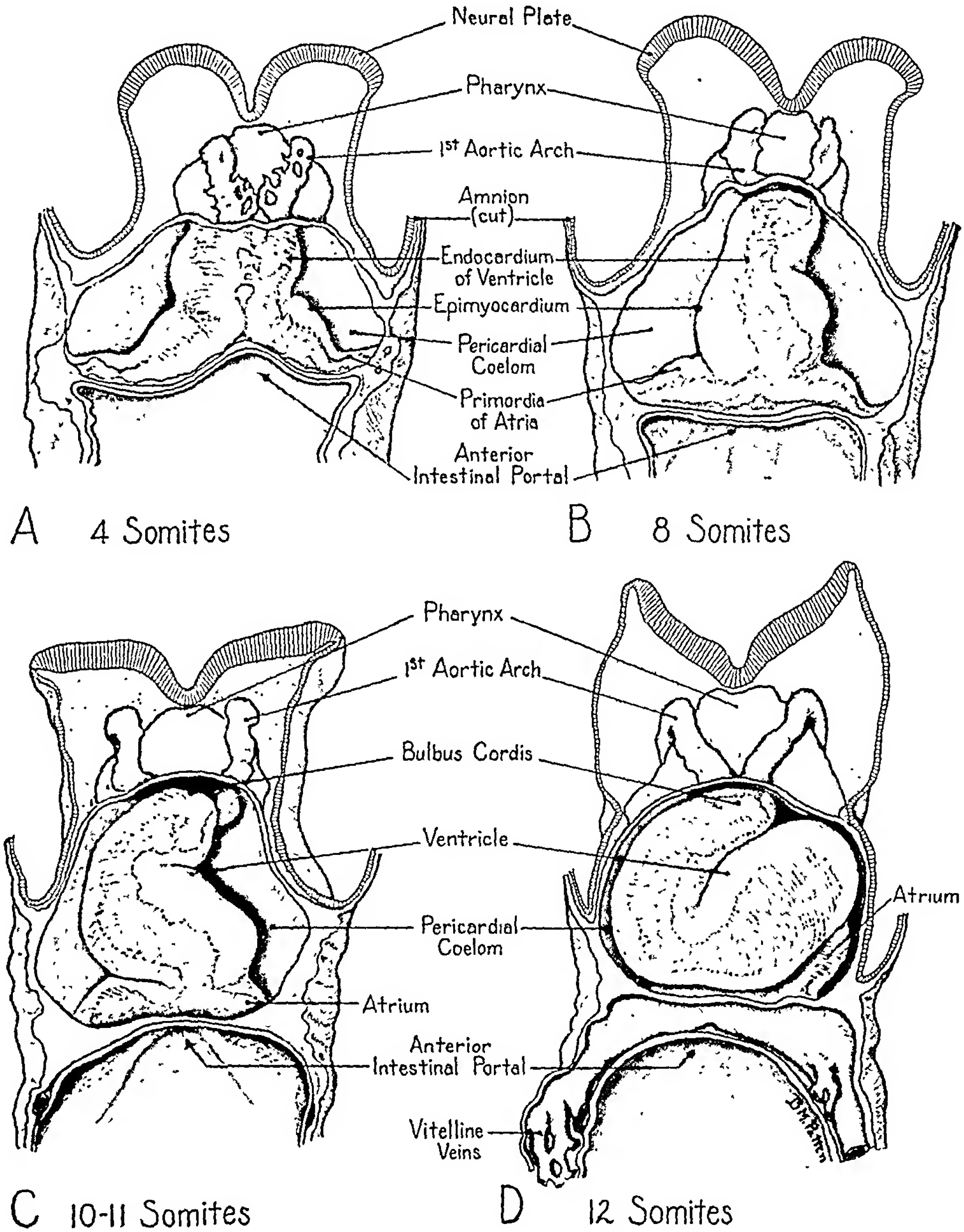

Fig. 189.—Four stages in the formation of the heart exposed by ventral dissection. (Combined from the figures of Davis, Carnegie Cont. to Emb., 1927, vol. 19.)

fluid within the uterine cavity—a method entirely inadequate to provide for the growth of the embryo except in its very early stages when its bulk is inconsiderable.

The heart of a human embryo begins to be formed during the third week of development from paired primordia situated ventrolaterally beneath

tubes continue beyond the cardiac region as branching strands which will become, anteriorly, the primitive aortae and, posteriorly, the afferent veins entering the heart (Fig. 189, A). The splanchnic mesoderm soon becomes markedly thickened where it is reflected laterally over the endocardial tubes to constitute the *epimyocardial layer* of the heart (Fig. 190, B).

Meanwhile folding off of the embryonic body is going on with concomitant progress in the closure of the foregut at the level of the heart. As a result the paired endocardial tubes are brought progressively closer together. Finally they are approximated to each other and fused into a single tube lying in the midline (Figs. 189, B and 190, C and D).

In the same process the epimyocardial layers are bent mesially, completely enwrapping the endocardium. Ventral to the heart the mesodermal layers of the opposite sides of the body become continuous with each other so that in the same process which establishes the heart as a median structure, the originally paired right and left coelomic chambers become confluent to form a median pericardial cavity (Figs. 190, C and D).

While these changes have been occurring in the cardiac region, the main vascular channels characteristic of young embryos are making their appearance. The cephalic prolongation of the endocardial tubes beyond the region in which the heart itself is formed constitute the start of the main efferent channels or aortae. The aortae are further extended by a process similar to that involved in the formation of the endocardial tubes themselves. Cords and knots of cells of mesodermal origin become aggregated along the course of the developing vessel. These strands of cells are then hollowed out to form tubes, walled by a single layer of endothelial cells. Where main blood vessels are about to become established there is found first a meshwork of these small channels. Gradually, some of these primitive channels are enlarged and straightened to form the main vessels and their walls are later reinforced by the addition of circularly disposed connective tissue fibers and smooth muscle cells. In this manner the primitive efferent channels are prolonged from the heart cephalad beneath the pharynx as the ventral aortae. They then bend laterad and dorsad about the pharyngeal walls to form *aortic arches*, and finally turn caudad to extend nearly the entire length of the embryo as the dorsal aortae (Fig. 191).

At first there is but a single pair of aortic arches which is located in the tissue of the mandibular arch. Later in development five additional pairs of arches connecting the ventral and dorsal aortae are formed. Each of these aortic arches lies in one of the visceral arches posterior to the mandibular. The entire series of aortic arches is never present at the same time, for the two anterior arches degenerate before the most posterior ones are formed. From the functional standpoint the significant thing is that blood passes by way of one or more pairs of aortic arches around the pharynx from the ventrally located heart to the dorsally located aortae which form the main distributing trunks of the embryonic circulation.

The main vessels serving to collect the blood which is distributed to all parts of the embryo by branches from the aortae are the *cardinal veins.* They arise by an entirely similar process, but are formed somewhat later than the aortae. There are two pairs of these vessels, the anterior cardinal veins draining the cephalic, and the posterior cardinal veins draining the caudal region of the body. At the level of the heart the anterior and the posterior

yolk sac. When this capillary plexus with its contained corpuscles has acquired open communication with the vitelline arteries on the one hand and the vitelline veins on the other, all the conditions necessary for active circulation of blood have been established. Under the pumping action of the heart, the fluid accumulated within the endothelium acts as a vehicle conveying the corpuscles formed in the blood islands of the yolk sac to all parts of the embryonic body.

No direct observations have been made on the beginning of the circulation of blood in the human embryo. But, reasoning from conditions known to exist in other embryos kept under continuous observation by tissue culture methods, we would probably not be far astray in placing the first heart beats as occurring toward the close of the third or early in the fourth week of development. In chick embryos, where the first cardiac contractions and the beginning of the circulation of blood have been observed and recorded by micromoving pictures, the first beats are spasmodic and interspersed with quiescent periods. There is a considerable interval between the first contractions of the growing heart muscle and the beginning of the circulation of blood. During this time the heart appears to be developing its power, for the beats become progressively stronger and more regular until finally the blood is set in motion. If the sequence of events in the human embryo is comparable to that in the chick, it would be five or six days after the heart showed its first twitching before it set the blood in motion—probably some time during the fourth week of development.

While the heart and the vitelline and intra-embryonic blood vessels have been developing, there has also been vascularization of the allantoic mesoderm which is being incorporated in the chorion to form the fetal part of the placental mechanism (Fig. 171, C). By the time the circulation of blood actually begins, there is a rich plexus of small vessels extending into the chorionic villi. This plexus is fed by the allantoic (umbilical) branches of the aortae and blood is returned from it to the heart by way of a pair of large veins, the *allantoic* or *umbilical veins*. The umbilical veins traverse the belly stalk and the lateral body wall, emptying into the posterior end of the heart along with the omphalomesenterics and the common cardinal veins (Fig. 191).

The significance of the vascular plan of the young embryo as outlined above is not difficult to understand. One needs only to bear in mind the rôle of the circulatory system in organic economics, and the basic morphological principle that an embryo must go through certain ancestral phases of organization before it can arrive at its adult structure. The primitive arrangement of vascular channels in young embryos and the changes they undergo during the course of development then form a coherent and logical story.

At the stage in which the circulatory system of a mammalian embryo begins to function it can be resolved into three simple sets of afferent and efferent channels with the heart as a common center. Each set of main channels with its interpolated capillary bed can conveniently be designated as a circulatory arc. One of these arcs, which we may call the intra-embryonic, consists of vessels lying wholly within the body. From the heart the blood is distributed by way of the aortae to all parts of the embryo. Small branches from the aortae break up into capillaries in the various organs,

its nitrogenous waste products through undeveloped kidneys. Its respiration and excretion, like its absorption of food, are carried out in the rich plexus of small blood vessels in the chorion. Here the fetal blood is separated from the maternal, by tissues so thin that it can readily give up its waste materials to, and receive food and oxygen from, the maternal blood stream, just as the mother's own tissues constantly carry on this interchange with the circulating blood. The placenta is thus the temporary alimentary system, lung, and kidney of the mammalian embryo. The large size of the umbilical blood vessels to the placenta is not a surprising thing—it is the entirely logical, the inevitable, expression of the conditions under which the embryo develops.

The enormous chorionic blood supply during fetal life, with the entire disappearance of this special arc of circulation when the organism assumes adult methods of living, is a very striking example of the determination of embryonic vascular channels by the location of functional centers. We must not, however, overlook the fact that there are many other centers of activity in the growing embryo less conspicuous but equally important for its continued existence. Each developing organ in the embryonic body is a center of intense metabolic activity. During fetal life it must be supplied by vascular channels adequate to care for its growth. But that is not all. Up to the time of birth each organ has been drawing on blood furnished with food and freed of waste materials by the activities of the maternal organism. At birth all this must change. Each organ essential to metabolism must be ready to assume its own active share in the process. Their vessels must be adequate to take care not only of the needs of these organs themselves but also of the functions these organs must now take over in maintaining the metabolism of the organism as a whole.

While the functional significance of the arrangement of the blood vessels is always of importance, especially in understanding the progressive changes in vascular plan, there is another factor which we cannot overlook. This factor is conservative, having to do with the things we inherit from our forebears. The goal of the embryonic period is the attainment of a bodily structure similar to that of the parents. Because it is so familiar, we accept with complaisance the remarkable fact that this goal is attained with absolute regularity. Accidents there may be, leading to defective development or malformation—but the fertilized ovum of a monkey never develops into a man. The new individual will show detailed differences from its parents, differences which are capitalized in the slow march of evolution; but in a single generation these differences are never radical. We say that the offspring has inherited the structure of its parents. It does more. It inherits the tendency to arrive at its adult condition by passing through the same sort of changes which its ancestors underwent in the countless millions of years it took their present structure to evolve.

Applied to the development of our own circulatory system this means that the earliest form in which it appears will not be a miniature of the adult circulation. The simple tubular heart pumping blood out over aortic arches to be distributed over the body and returned to the posterior part of the heart by a bilaterally symmetrical venous system, in short the vascular plan which we see in young mammalian embryos (Fig. 191), is essentially the plan of the circulation in fishes. When we realize this, we are not puzzled either by the

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to man definite information is lacking. On certain comparative grounds Grosser[2] and others argue that an interval of six or seven days would theoretically appear to be about correct, but Teacher[5] prefers to halve this estimate. In all mammals the upper half of the tube is traversed quickly but the egg makes much slower progress as the lumen narrows.[4] The forces that move the ovum onward are not surely known; the time-honored belief in the efficacy of downward beating cilia[6, 7] is being sharply challenged by those who hold that muscular tubal movements are the effective agent[3, 8] or that both forces may be involved.[9]

On its arrival in the uterus the mammalian ovum has progressed to a cleavage cluster.[9] The follicular cells of the corona radiata are already lost but the encapsulating zona pellucida membrane is still present. Naturally enough, the embryonic cell cluster has not increased in size; until implantation brings the mass into contact with adequate utilizable nutriment the developmental process is essentially one of cell fractionation without true growth. As far as may be surmised, in the absence of actual illustrative specimens, the human embryo should be in a similar condition. Since the mature human egg measures 0.13–0.14 mm. in diameter[10] it follows that the size at this time would be approximately the same. Several additional days elapse before the mammalian embryo becomes nested within the endometrium. During this interval the embryo is transported further to its final implantation site, development continuing the while. Cilia have usually been held responsible for this transfer,[2] but in some mammals, at least, it seems necessary to assume the operation of a muscular factor.[11] This is because such animals show great regularity in the sites selected and in the spacing of individual embryos. In man the place of implantation varies widely, although it is usually at a high level in the uterus and commonest (and with equal frequency) on either the anterior or posterior wall. Occasionally a lateral location is chosen; very rarely implantation occurs near the cervix, whence the resulting placenta praevia may cover the cervical canal and introduce complications at delivery. In any event there is no longer reason to believe that the point of entry bears any necessary relation either to the mouths of uterine glands, which are too small to offer lodging, or to mucosal folds or furrows.[2, 5] In fact, the premenstrual endometrium is swollen and smooth at the time of implantation, whereas foldings are first characteristic of the young gravid state. In man it is impossible to know whether chance or special qualities of the mucosa govern the selection of the site. Conceivably the more pronounced premenstrual changes occurring in the fundus, and especially in the median planes, are significant

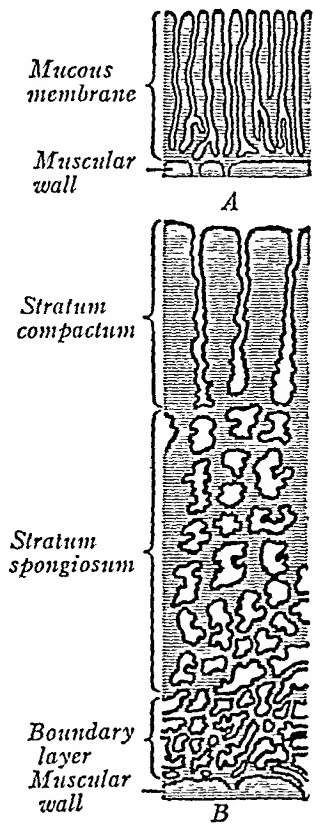


Fig. 192.—Diagrammatic sections of the uterine mucous membrane (× 15). (After Kundrat and Engelmann.) *A*, Resting condition. *B*, Premenstrual enlargement at the beginning of pregnancy.

man embryo into the endometrium has not been observed directly it is believed to parallel the general course of events in the guinea-pig. At the time of penetration the zona pellucida of the guinea-pig (Fig. 193, *A*), and presumably of man, is lost, so that the embryonic mass is henceforth free to increase in size. At this period the human embryo is thought either to consist of an inner mass of cells and a peripheral, encapsulating trophoblast layer, or perhaps to have advanced to the stage of a hollow blastocyst with an embryonic mass concentrated at one pole (Fig. 194, *A*).[5] The embryo is credited with burrowing inward, somewhat like a parasite, by destroying the maternal tissue in its path. Entry is presumably accomplished through an enzymic digestive activity of the external trophoblastic layer (Fig. 193, *A*), aided by

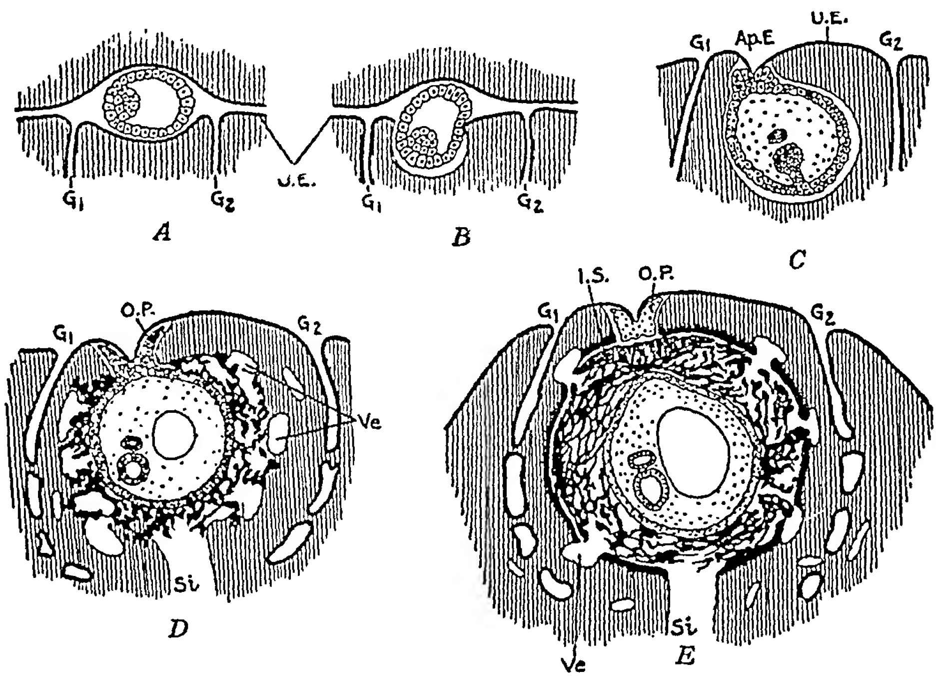


Fig. 194.—Diagrams of the human embryo representing stages during the first five days of implantation. (Woollard, after Teacher.) *A–C*, Hypothetical stages (a morula perhaps should replace the blastocyst of *A* and *B*); *C*, Miller ovum; *D*, Bryce-Teacher ovum. The black meshwork of *C* and *D* is plasmotrophoblast.

Ap.E, Entrance aperture; G_1, G_2, uterine glands; *I. S.*, fibrin clot; *O. P.*, trophoblast; *Si*, venous sinus; *U. E.*, uterine epithelium; *Ve*, blood vessels.

the amebism of the trophoblast cells which advance the embryo into the space progressively created. Increased swelling of the mucosal margin about the site of entry may facilitate the process of enclosure. Tissues encountered in course undergo visible dissolution and liquefaction and lymph-like spaces appear that seemingly are not artefacts (Fig. 193, *A*). Even as penetration proceeds, the human embryo is suspected of having a definite polarity in which the future embryonic end lies deepest (Fig. 194, *B*, *C*).[5] The entire events of penetration are estimated to occupy not more than one day. The superficial wound in the mucosa is closed by a portion of the trophoblast (the 'operculum'; Fig. 194, *D*) which later detaches from the embryo and is reinforced by a fibrin clot (Figs. 194, *E*, and 196).[13] The position of the im-

type of nutrition is effected, the relative amounts of cellular and syncytial trophoblast vary greatly. Grosser believes there are two periods, in both of which each type becomes dominant.[2] The first generation of cellular and syncytial trophoblast is especially concerned with the erosive activities leading to the establishment of the embryo in the mucosa. The second generation, on the other hand, is used primarily for clothing the villi and effecting the proper absorption of maternal fluids from the opened sinuses.

The stage of the first generation of trophoblast is represented by the specimen SCH of von Möllendorf (twelve to thirteen days old?),[14] in which syncytium is just appearing, by the Miller embryo (thirteen to fourteen days old) (Fig. 170, p. 407),[15] in which luxuriant syncytium is present, and by the Bryce-Teacher specimen (fifteen to sixteen days old)[5, 16] which illustrates the initial decline of this syncytium peripherally (Fig. 195). The spread of the trophoblast is probably accomplished by a digestive action exerted upon the decidua, which then allows the trophoblast to occupy the spaces thus created, rather than by a direct, penetrative process. The cellular trophoblast has sometimes been credited as the sole eroding agent but it seems that to the first generation of syncytium, at least, must be ascribed a similar function. The

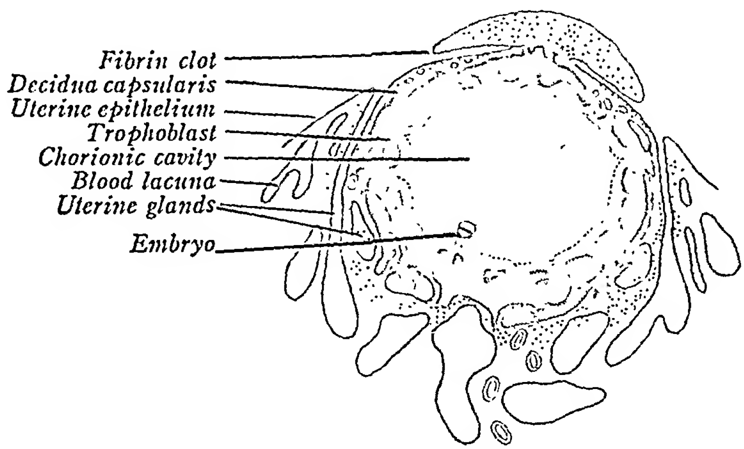


Fig. 196.—Peters' human ovum of about seventeen days, sectioned vertically *in situ* (× about 7). (After Peters.)

period under discussion is also characterized by the presence of cavities within the spongy trophoblast (Fig. 195). These lacunae contain maternal blood elements and tissue detritus which presumably are utilized by the embryo as nourishment and for this reason have been designated as embryotroph. Many young, human specimens show a maternal blood sinus beneath the implanted embryo (Fig. 194).

The well-known Peters embryo (seventeen to eighteen days old) illustrates the decline of the first generation of syncytium and the appearance of the second exuberant growth of cellular trophoblast (Fig. 196).[17] The latter tissue extends as columns through large blood lacunae which in most cases communicate with opened maternal vessels (Fig. 197). Such trophoblastic trabeculae can be called *primary villi*. The irregular lacunae at this time are bounded partly by cellular trophoblast and partly by new syncytium which is no longer spongy and honey-combed but, on the contrary, resembles the later flattened, placental type. It is designated the absorptive or villous syn-

the end of the embryotrophic period but it still continues into the early hemotrophic stage. The purposes of the embryotrophic period are accomplished when embryotroph is no longer needed, when the decidua is sufficiently excavated, and when the hemotrophic nutrition is realized. Naturally, there is no sharp division between these two periods. The thickness of the compact decidua limits the severity of the erosion, and its time duration of about ten days is relatively short. Many have interpreted the halting of the trophoblastic invasion as being due to a defensive counter-attack on the part of the mucosa in which its enlarged and otherwise modified stromal, or decidual cells are the conspicuous agents.[5] Others see, rather, a nicely worked out co-operation to produce a definite, harmonious end, rather than a ruthless attack and an equally vigorous defense.[2]

As early as the stage of the Peters embryo the mesoderm is beginning to extend as axial cores into the trophoblast to produce stubby *secondary*, or *true villi* (Fig. 197). In the Mateer specimen of nineteen days the villi are branching (*cf.* Fig. 201), and in their vicinity the trophoblast is reduced to

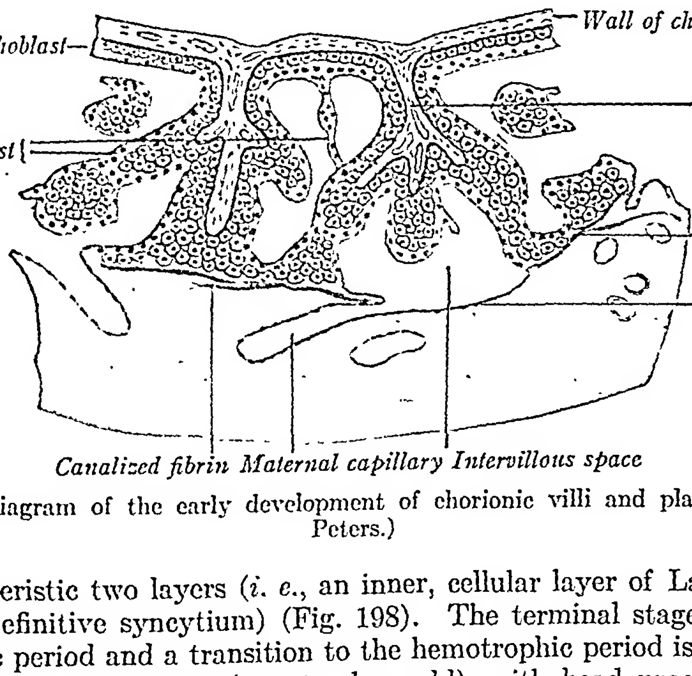


Fig. 198.—Diagram of the early development of chorionic villi and placenta. (After Peters.)

the characteristic two layers (*i. e.*, an inner, cellular layer of Langhans and an outer, definitive syncytium) (Fig. 198). The terminal stage of the embryotrophic period and a transition to the hemotrophic period is represented well by the Frassi embryo (twenty days old), with head process and low neural folds already present.[19] Growth of the whole specimen, and the enlargement of its villi without a corresponding increase in the ectodermal, cellular trophoblast, have used up the formerly thick trophoblastic shell. From it have come the two epithelial layers of the increasingly abundant and progressively branching villi. Also it has furnished the *basal ectoderm*, which covers the eroded uterine surface, and other trophoblast which continues to wander into the decidua and disintegrate there. Yet it is plain that penetration is not so active as formerly, that the transition region is less pronounced, and that the destruction of tissue is gradually slowing. At about this time begins the formation of *fibrinoid striae* at the periphery of the trophoblast (Fig. 198). This material, to be discussed in a later paragraph, presents an effective barrier to further penetration.

(certain marsupials and insectivores) this nutritive path ('yolk-sac placenta') continues throughout gestation. In sharp contrast stands the condition characteristic of the primate group, including man. These animals not only have a small yolk sac from the beginning but also it remains diminutive in comparison to the chorion (Fig. 199). All vertebrate yolk sacs have the same essential structure. The primary tissue is an epithelial (entodermal) vesicle which may or may not enclose a yolk content; external to this is a covering of splanchnic mesoderm which bears the vitelline blood vessels (Figs. 200 and 201).

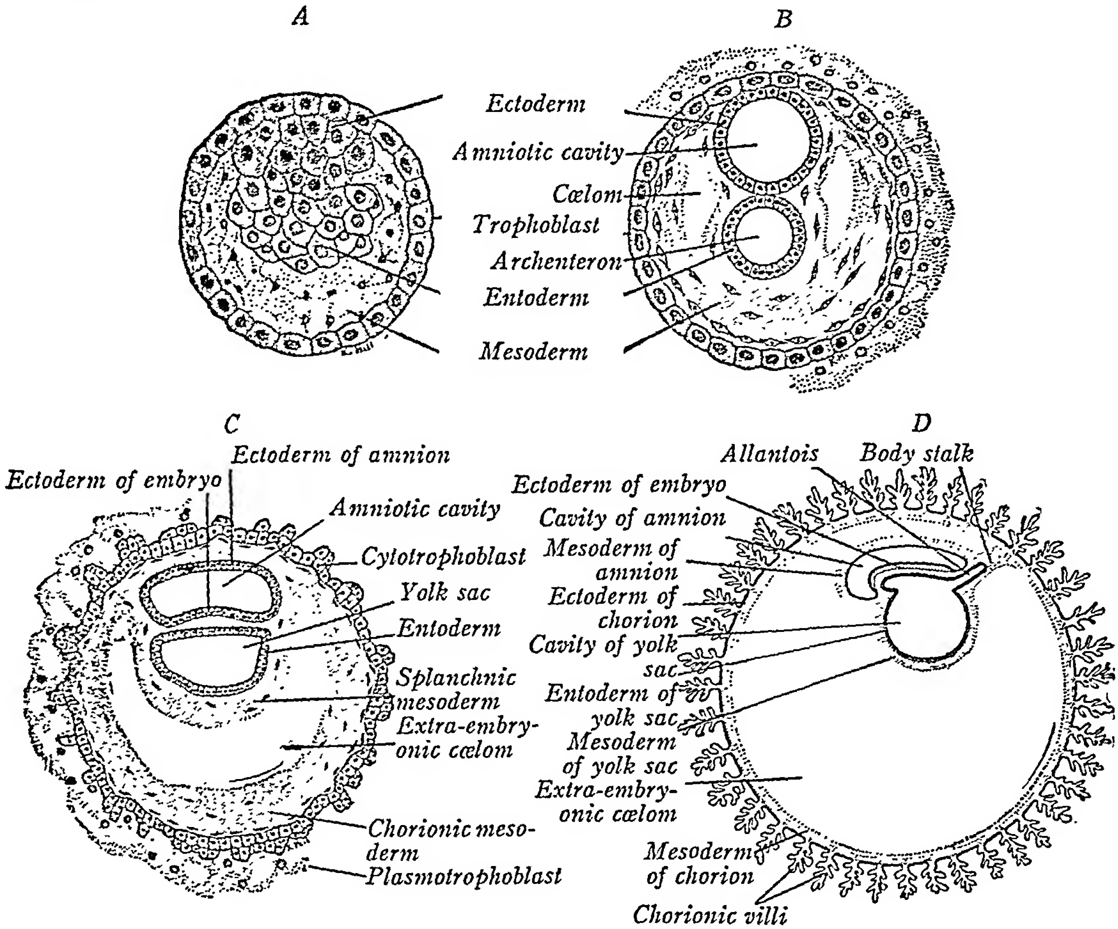


Fig. 199.—Diagrams of early human embryos (adapted by Prentiss). *A*, Hypothetical (younger than Miller); *B*, Bryce-Teacher (modified); *C*, Peters; *D*, Spee.

The human yolk sac was formerly called the *umbilical vesicle* because of its shape and place of attachment. As in other true mammals this organ (also called the vitelline sac) receives from the almost yolkless egg no appreciable amount of actual yolk substance. It does, however, contain a coagulable fluid and in the earliest stages this includes globular masses. From the standpoint of nutrition the human yolk sac is without functional significance, and the albuminous content of the cavity must be largely acquired secondarily since the sac becomes many times the size of the original ovum.[22] Nevertheless, the roof of the sac is highly important by providing the epithelial lining of the digestive system (Fig. 199). Blood cells and blood vessels arise at an

In the youngest human specimens known (*e. g.*, the Bryce-Teacher embryo, at the end of the second week) the yolk sac is already a small vesicle, lined with a single layer of entoderm and surrounded with mesoderm (Figs. 195 and 200). At a period of development when the first somites are appearing (embryos of about three weeks) the sac is approximately equal to the length of the embryo proper (Fig. 201). Toward the end of the fourth week the entodermal roof of the vesicle begins to form the foregut and hindgut, and the primitive enteric system as a whole is then connected by a slightly narrowed region to the yolk sac proper (Fig. 204). With the continued rapid growth of the embryo's body there is an apparent progressive constriction of embryo from yolk sac (Fig. 207). The constriction is, of course, only relative since both embryo and yolk sac enlarge whereas their region of union lags (Fig. 202). This slenderer connection does, however, elongate greatly and

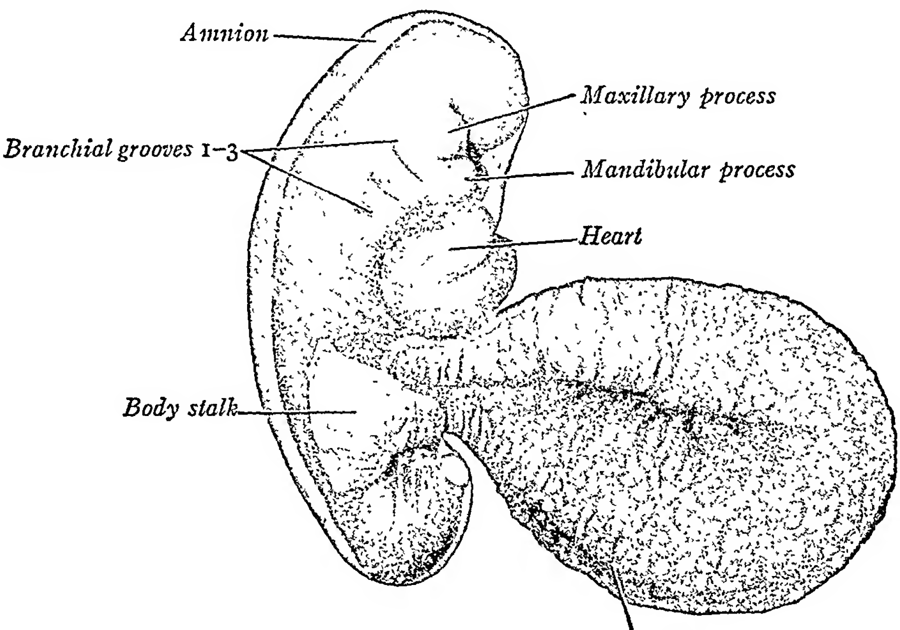


Fig. 202.—Human embryo of 2.6 mm. (× 25). (His.)

becomes the yolk stalk which is soon incorporated into the umbilical cord (Figs. 205 and 207). The yolk stalk in early stages is hollow and lined with single-layered entoderm. This entodermal tube (sometimes called the vitelline duct) usually detaches from the intestine in embryos about 7 mm. long (early in the sixth week of development); nevertheless, it may remain connected until into the next week (13 mm.). The vitelline duct lies in what may be considered a prolongation of the mesentery, and the whole columnar structure, including the associated vitelline blood vessels, is properly known as the yolk stalk. After detachment occurs, the cavity of the yolk stalk is promptly obliterated and even the entoderm disappears. This condition may be found in embryos of some seven weeks, but remnants of the yolk stalk have been reported up to the third month, and portions of the blood vessels even later.

The human yolk sac is a pear-shaped vesicle which attains an average

Allantoic (umbilical) blood vessels accompany the allantois, reach the chorion and vascularize it. When the human chorion becomes a part of the placenta, this latter organ performs all the functions of nutrition, respiration, and excretion. In many mammals the allantois, as a placental component, is intimately concerned with these functions, but in man the allantois, like the yolk sac, becomes physiologically a superseded rudiment. Its chief value lies in the blood vessels which accompany it and put the embryo into physiologic connection with the maternal circulation (Fig. 212). Modern investigations do not support the former belief that the allantois enters into the composition of either the bladder or urachus.

The Amnion.—In the youngest normal human embryo yet known (the Miller specimen, of thirteen to fourteen days) the amnion cavity has just appeared as a distinct space (Fig. 170, p. 407), while embryos only a few days

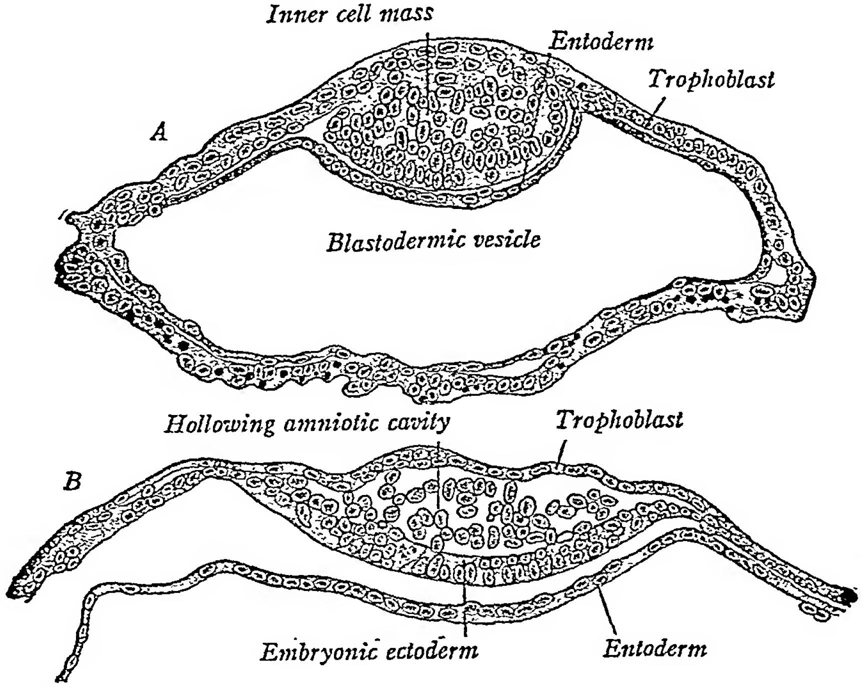


Fig. 203.—Stages of amnion formation in the bat (× about 160). (Van Beneden.)

older have a prominent amnion (Fig. 199). Although the general method of formation of both the amnion and chorion in reptiles, birds, and most mammals is by folding of the extra-embryonic somatopleure, this plan, nevertheless, is not followed in some animals (*e. g.*, the bat, guinea-pig, hedgehog, and primates). Instead, fluid-filled clefts appear in the interior of the solid ectodermal cell mass; these quickly coalesce and the resulting enclosed space is the primitive amnion cavity (Fig. 203). The floor of the space is the plate of embryonic ectoderm; the sides and roof comprise the thinner amnion membrane. It must be assumed that the human amnion also originates in this manner although illustrative stages are not known. Both the Miller and Bryce-Teacher embryos possess an ectodermal amnion sac but they still lack a coelomic cleft within the mesoderm which has precociously arisen between the embryonic mass and the trophoblastic capsule. One or two days

(Fig. 212). The amnion then fuses loosely with the chorionic wall, the two fibrous layers combining (Fig. 210, *A*); this naturally results in the obliteration of the extra-embryonic body cavity (Fig. 219).

Amniotic fluid fills the sac. It is a clear, alkaline liquid, made slightly milky by suspended particles of vernix caseosa. Chemically the amniotic fluid contains albumins, urea, fats, inorganic salts, and enzymes. These solid constituents comprise only 1 per cent of the total fluid. The immediate origin of amniotic fluid (fetal or maternal) and the possible participation of the amnion in this process are disputed. During the early months of pregnancy the fetus is suspended by its umbilical cord in this fluid (Fig. 212), and throughout gestation the amniotic fluid serves as a protective water cushion which absorbs mechanical insults, equalizes pressures and prevents adherence of the amnion (Fig. 219). Throughout its months of immersion the embryo is supposed to be protected from maceration by the fatty vernix caseosa

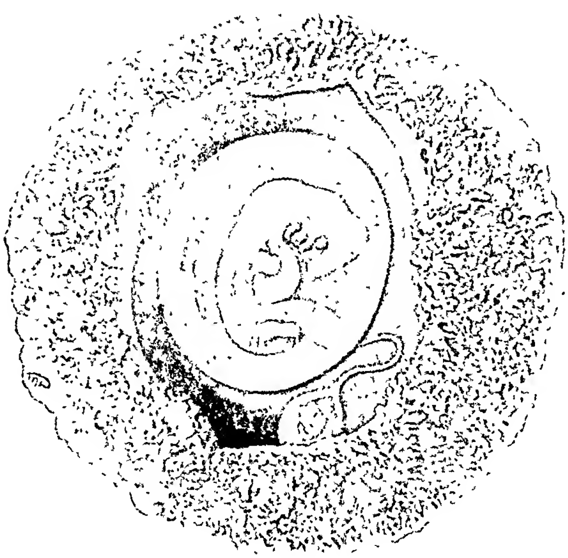


Fig. 205.—Chorionic sac opened to exhibit an 11 mm. human embryo within its unruptured amnion (× 2). (Arey, 'Developmental Anatomy.')

smeared on the skin. At childbirth the amniotic sac acts as a fluid wedge to dilate the uterine cervix. During the first stage of labor the membranes usually rupture and about a liter of amniotic fluid escapes as the 'waters.' If the tough amnion fails to burst, the head is delivered enveloped in it and is then known popularly as the 'caul.' When the amount of amniotic fluid exceeds two liters the condition is designated *polyhydramnios.* A volume smaller than 500 cc. is termed *oligohydramnios,* and a marked deficiency may allow the amnion to adhere to the embryo and cause injury. It should be emphasized, however, that the fibrous amniotic bands, so-called, which pass from amnion to embryo appear to be the result of local necrosis of fetal tissues rather than amniotic derivatives that cause specific injuries.[23]

The Chorion.—In reptiles, birds, and many mammals the chorion is produced by the same process of folding that gave rise to the amnion. The outer lamella of the fold becomes the chorion and this surrounds the embryo and all other of its fetal membranes. On the other hand, the same group of

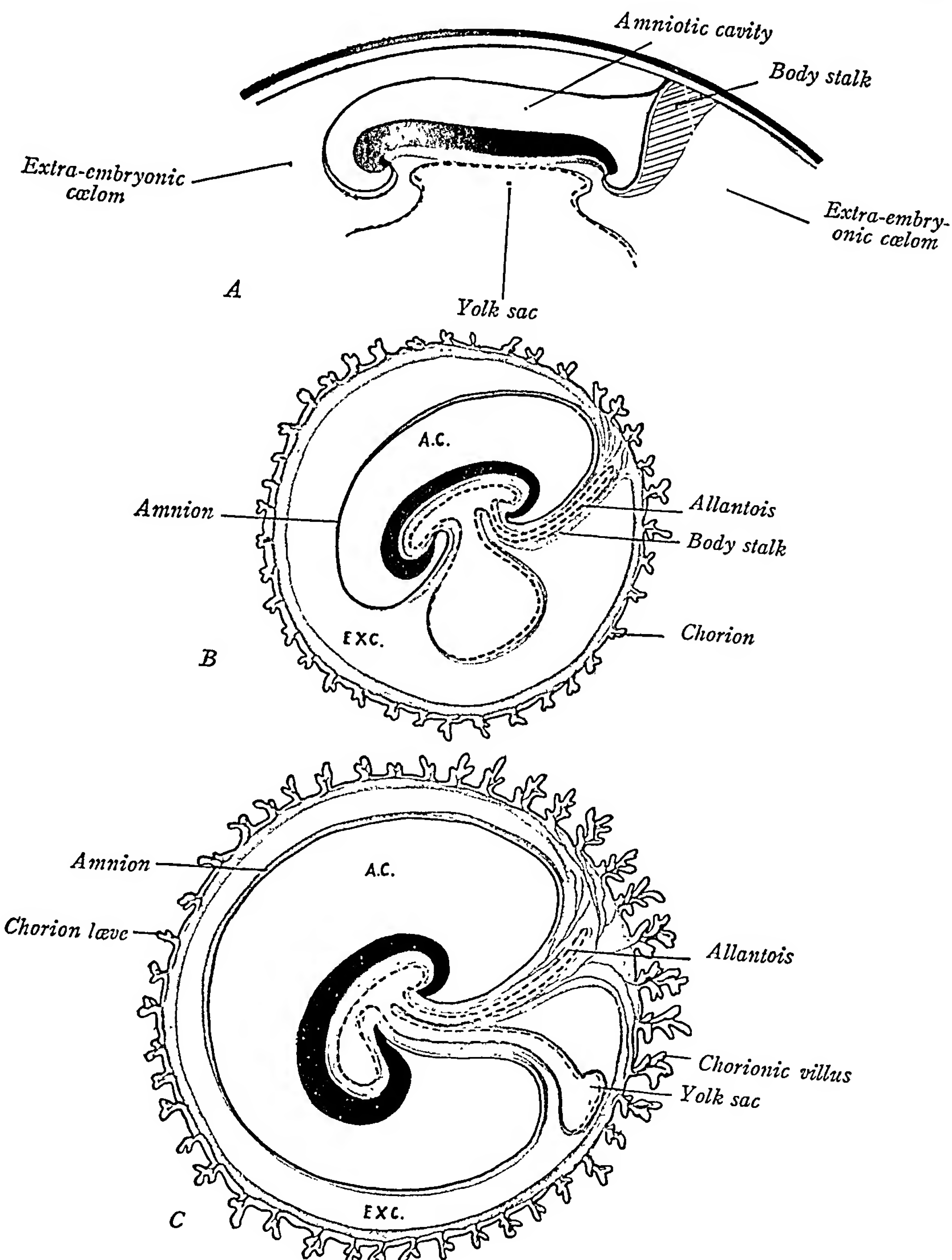


Fig. 207.—Diagrams of the early development of the human umbilical cord (DeLee). *a.c.*, Amniotic cavity; *exc.*, extra-embryonic coelom; solid black, ectoderm; red, mesoderm; dotted black, entoderm.

the chorion which constitutes the fetal half of the placenta (Figs. 212 and 219).

The umbilical cord is covered with simple ectodermal epithelium (squam-

the intestine was normally withdrawn can produce the same final condition. The production of atrophy and amputation by the cord winding about the neck or extremities of a fetus is often alleged but without convincing proof.

THE DECIDUAL MEMBRANES

The mucosal lining of the uterus, already altered in anticipation of pregnancy and first utilized as a nidus for the implanting embryo, rapidly acquires the characteristics of a gravid membrane and then continues as an important structure throughout the duration of pregnancy. Naturally enough, the most profound changes occur in that part of the endometrium which combines

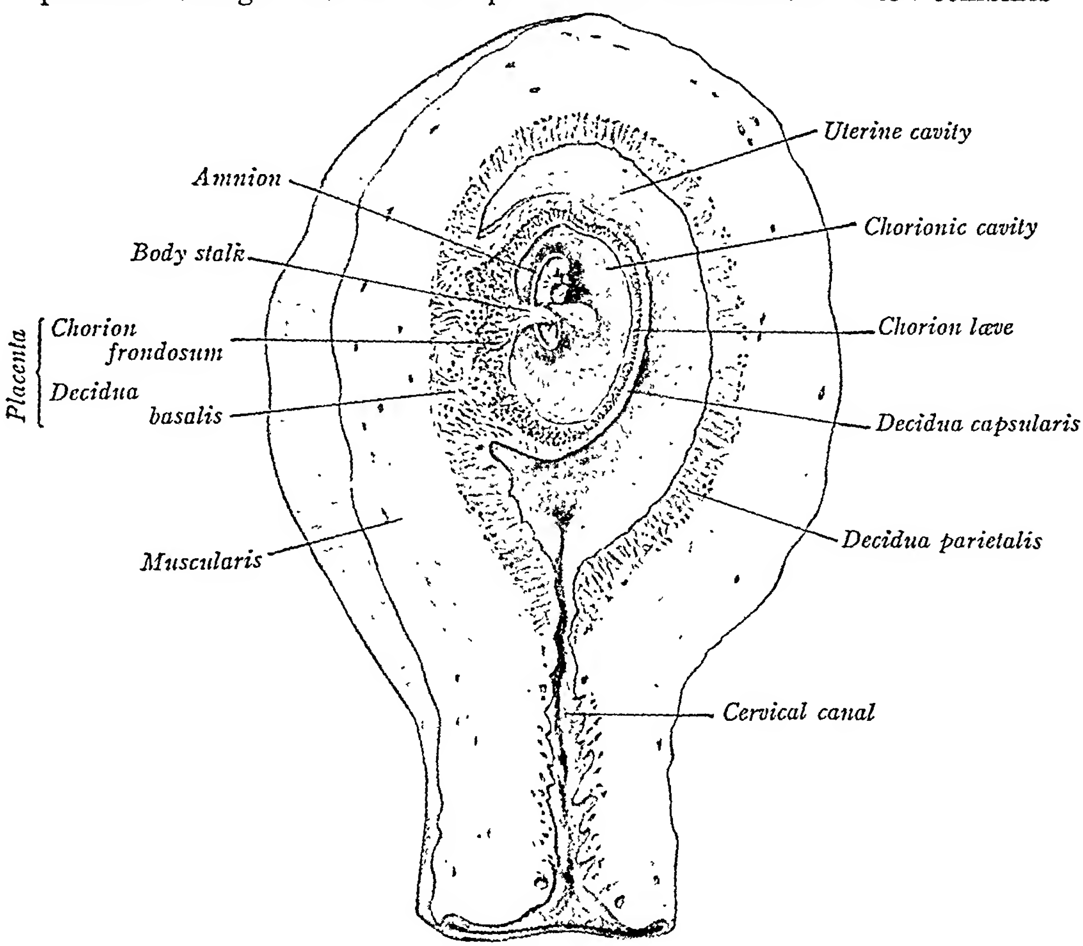


Fig. 209.—Gravid uterus of slightly over one month, in semidiagrammatic longitudinal section to indicate the relations of the embryo to the deciduae. About natural size. (Arey, 'Developmental Anatomy.')

with the chorion to form a placenta. Nevertheless, the remainder of the mucosa is modified in somewhat the same way and has its characteristic history as well. The intimate fusions that are effected between these maternal tissues and the expanding fetal tissues which everywhere come in contact with them necessitate an extensive sloughing of the uterine lining at birth. The mucosa of the pregnant uterus is, therefore, named the decidua (*i. e.*, that which falls off). Its preparation for gestation, the long deferred loss at parturition, and the subsequent repair after childbirth exaggerate and extend the events of

For the first two months of gestation the long axes of the uterine glands lie vertical with respect to the mucosa. Later, as the parietal decidua is stretched through expansion of the uterus and compressed through growth of the fetus, the glands are broadened and shortened and their cavities become elongate clefts parallel to the surface (Fig. 210, *A*). The period of growth and enlargement of the decidua parietalis is limited to the first three or four months of pregnancy, during which period it attains a maximum thickness of nearly one-half inch. Later it becomes thinner, loses much of its early vascularity, and exhibits actual regressive changes. The uterine cervix does not regularly elaborate a decidua; its glands, however, do enlarge and secrete a mucous plug which closes the uterus during the period of gestation (Fig. 212).

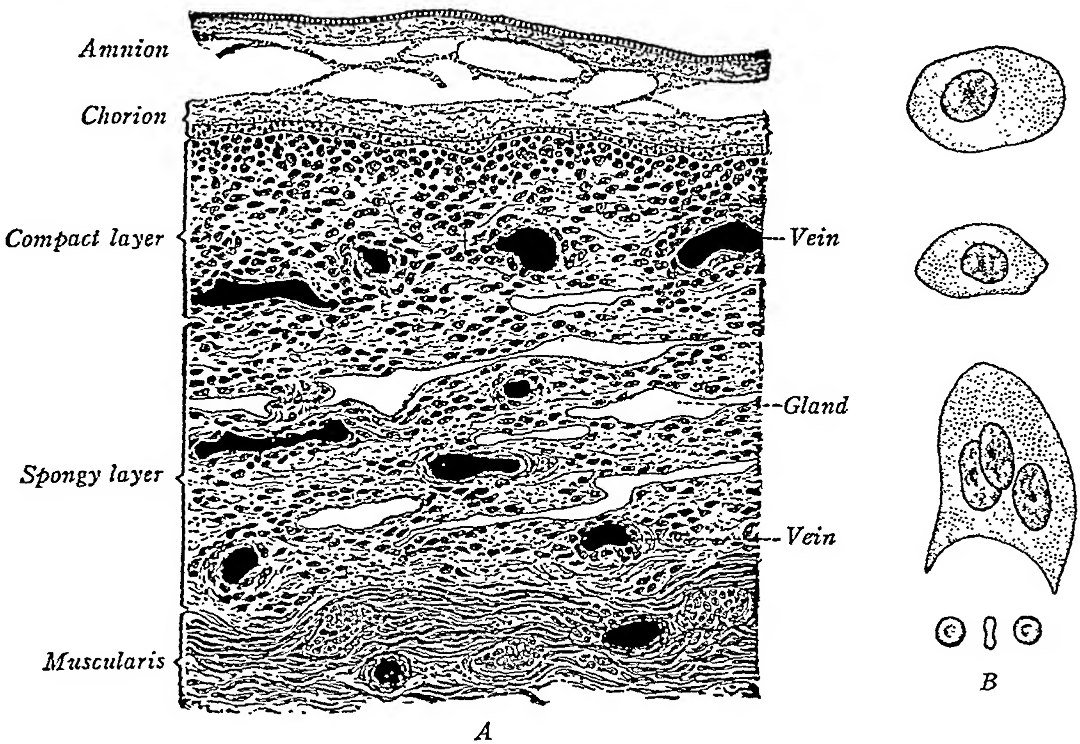


Fig. 210.—*A*, Vertical section through the decidua parietalis of about seven months, with the attached fetal membranes *in situ* (× 30). (Schaper in Lewis and Stöhr.) *B*, Decidual cells from a uterus at the end of pregnancy; below are three red blood corpuscles drawn to scale (× 450). (Arey, 'Developmental Anatomy.')

The Decidua Capsularis.—The part of the endometrium that originally lies between the embryonic sac and the uterine cavity is the *decidua capsularis* (Figs. 209, 211, *B*, and 212). Formerly it was called the decidua reflexa from a mistaken notion as to its method of formation by folding. In the earlier stages of pregnancy parts of glands and blood vessels occur in the substance of this layer, and the surface epithelium is continuous with that of the decidua parietalis; for a short time the site where the embryo gained entrance is demonstrable (Fig. 193, *B*). As the chorionic sac expands, the capsularis grows thin and atrophic. At the end of the third month its full surface comes into contact with the decidua parietalis with which it fuses, thereby obliterating the uterine cavity (Figs. 212 and 219). Some-

pregnancy this portion of the deciduae resembles somewhat the parietalis (*cf.* Fig. 210), even though there are at first superficial erosions and blood extravasations caused by the activity of the chorionic trophoblast. The decidua basalis does not share in the retrograde changes common to the other deciduae but maintains itself until birth as a component of that important organ named the placenta (Figs. 217 and 218). The decidual tissue is said also to help in preventing excessive hemorrhage during the earliest part of pregnancy by acting as a dam between the chorionic trophoblast and the eroded uterus.[21]

THE PLACENTA

In earlier paragraphs have been traced the penetration of the ovum into the lining membrane of the uterus and the incidents connected with its implantation there at a superficial level. The chorionic sac was seen first to develop primary, trophoblastic villi and then permanent, highly branching ones containing extensions of blood vessels which pass from the early embryo and ramify throughout the connective tissue component of the definitive chorion. The erosion of the maternal mucosa was also described, whereby

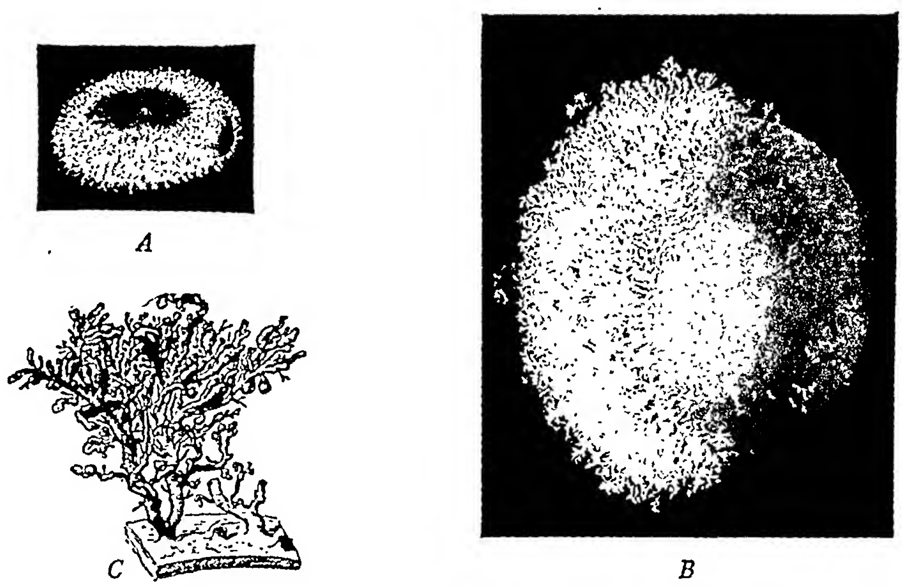


Fig. 213.—*A*, *B*, Human chorionic vesicles of five and seven weeks (DeLee); the chorion laeve of the younger specimen is premature. *C*, Model of a chorionic villus at the end of two months (× 6). (After Corning.)

sinus-like spaces arose which communicated with opened arteries and veins. This intimate association between chorionic villi and uterine 'blood' sinuses is the material basis of that structure of combined fetal and maternal origin which is named the *placenta*.

The shape of the human placenta is due to the final distribution of villi on the chorionic sac. At first villi cover evenly the entire surface of the chorion (Fig. 213, *A*). As the embryo and its sac enlarge simultaneously, the villi next the stretched decidua capsularis become compressed and their vascularity is reduced (Fig. 212). At seven weeks these villi are plainly shorter than those next the decidua basalis. Normally, however, (although pathologic specimens may show a great reduction) it is not until into the third

next the connective tissue, is the parent *cytotrophoblast* layer (of Langhans) with its separate cuboidal cells sharply defined. This cellular layer undoubtedly gives rise to an outer syncytium, the *plasmotrophoblast*, but convincing illustrative stages are singularly hard to find. The plasmotropho-

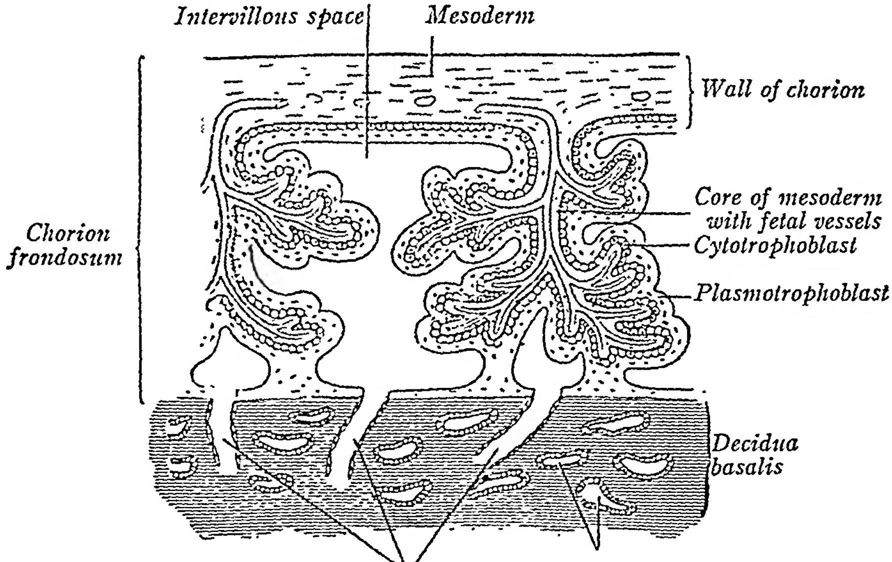


Fig. 215.—Diagrammatic section through a later placenta with secondary chorionic villi. (After Bryce.)

blast covers the villi externally. Trophoblast also is found on the parent chorionic membrane (between the roots of villi) and it likewise spreads over the eroded uterine surface (Fig. 215); in this manner the trophoblast serves for a time as a complete lining to the placental sinuses (Fig. 218). During the first half of pregnancy the cytotrophoblast of the villi is completely

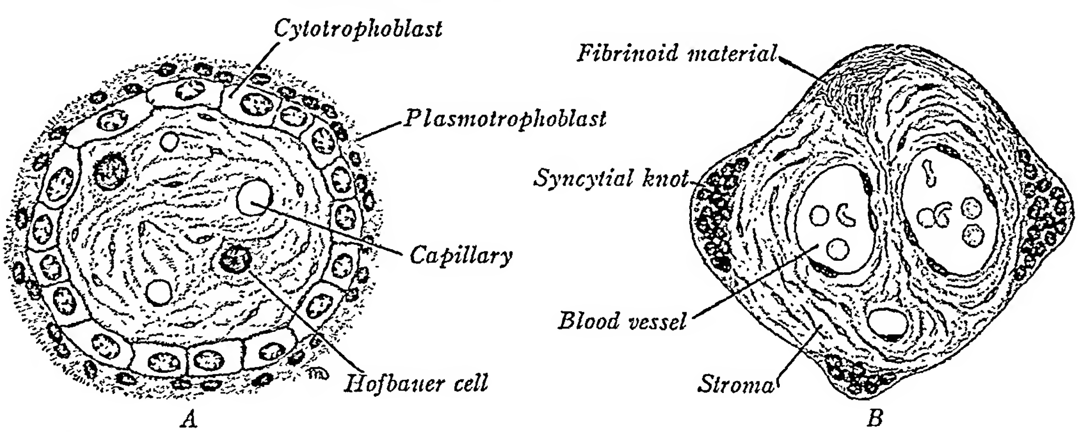


Fig. 216.—Human chorionic villi in transverse section (× 265). *A*, In the early weeks of pregnancy; *B*, at full term. (Arey, 'Developmental Anatomy.')

used up in the forming of syncytium; for this reason this cellular layer becomes progressively scarcer and more interrupted as pregnancy proceeds, until finally the plasmotrophoblast is the only epithelial coat of the villi during the later months (Fig. 216, *B*). The free surface of the syncytium often

is usually more than one cell deep and decreases in amount as pregnancy continues. At term the basal ectoderm occurs discontinuously, interspaced by deposits of fibrinoid material.

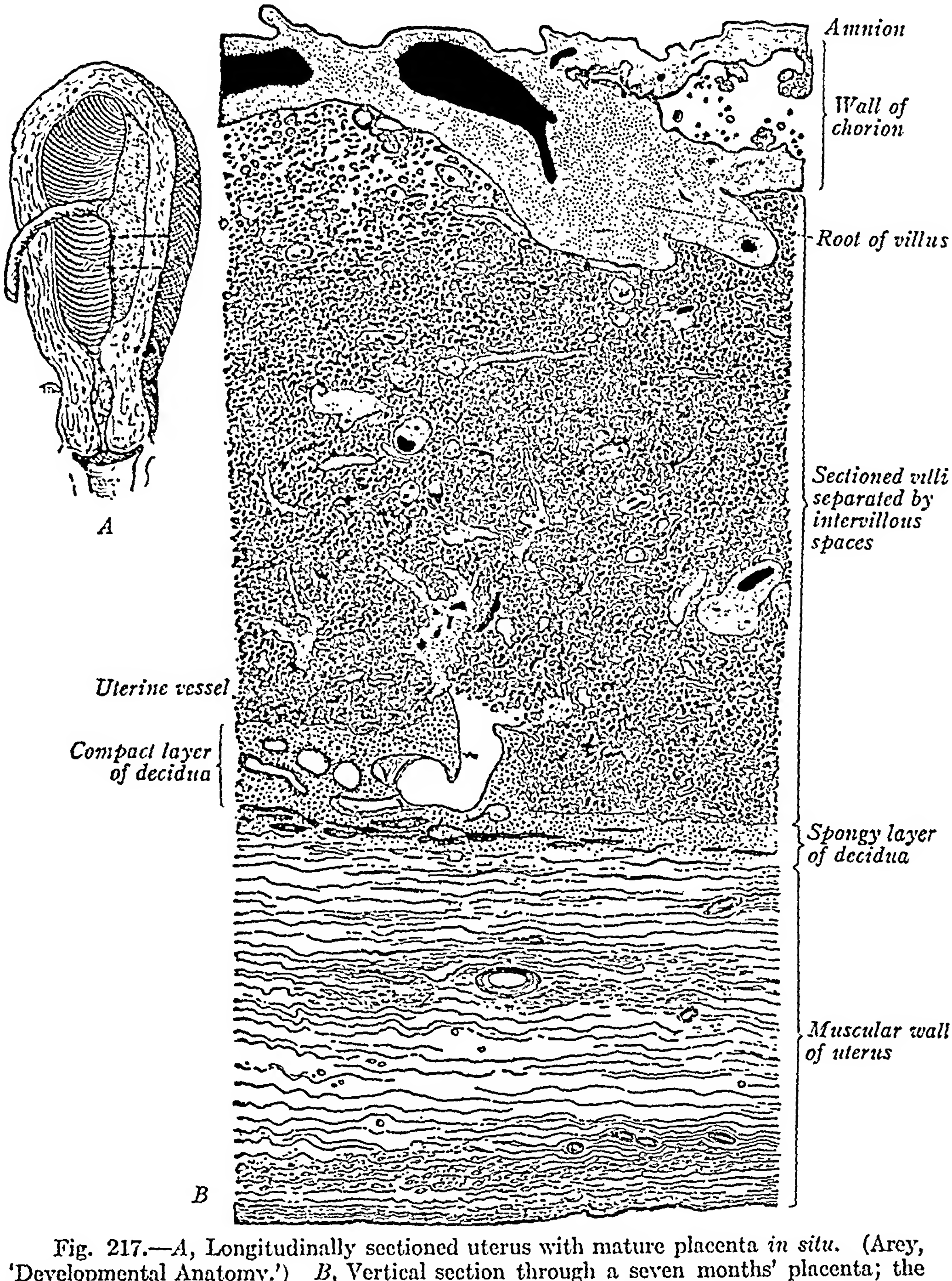


Fig. 217.—*A*, Longitudinally sectioned uterus with mature placenta *in situ*. (Arey, 'Developmental Anatomy.') *B*, Vertical section through a seven months' placenta; the zone included is set off by dotted lines in *A* (× 5). (Minot.)

Portions of the decidua may be found at intervals extending outward from the basal plate into the intervillous space. The tips of some villi are inserted in their substance but such elevations do not unite with the chorionic

quently sucked into the veins and so interfere with the placental circulation. At the periphery of the placenta is an enlarged channel which varies in extent but never encircles the margin completely. This space is the *marginal sinus* through which part of the circulating fluid is drained from the placenta into maternal veins (Fig. 219).

The occurrence of an actual intervillous 'circulation' can neither be interpreted too literally nor accepted too readily. According to Mall there is little evidence of it, since the trophoblast plugs maternal vessels as soon as they are eroded; the compact decidual tissue also prevents excessive hem-

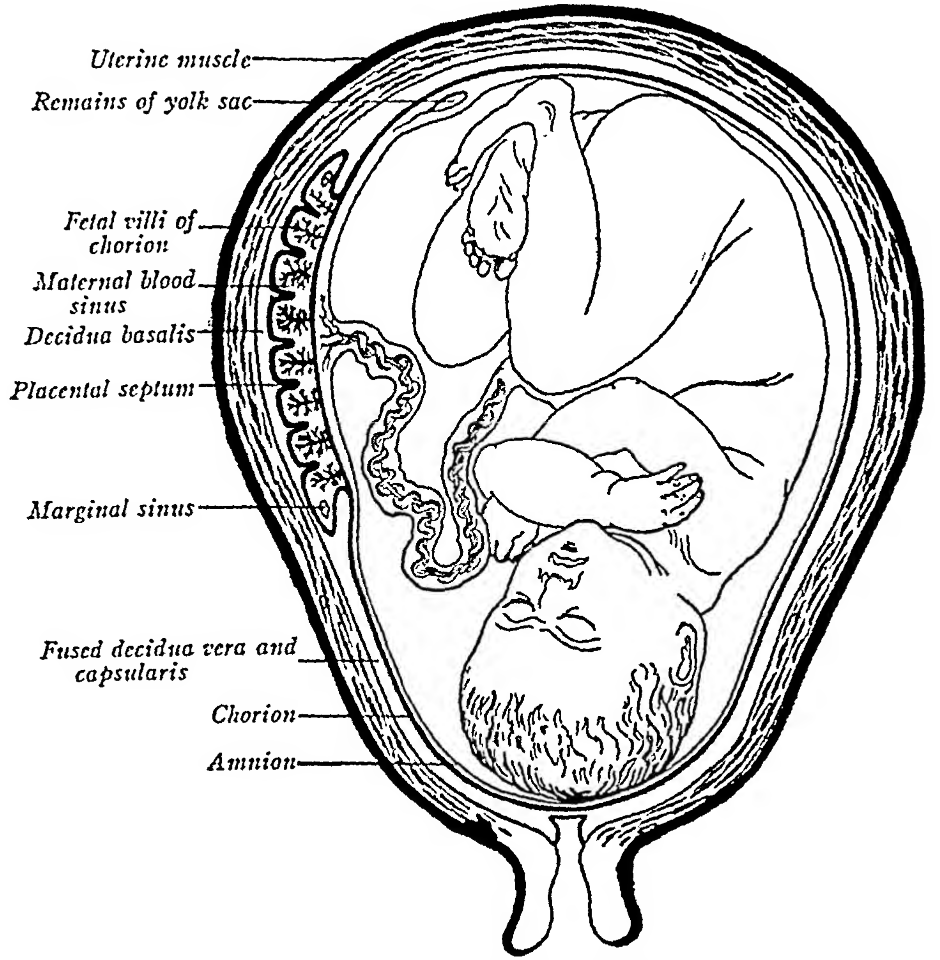


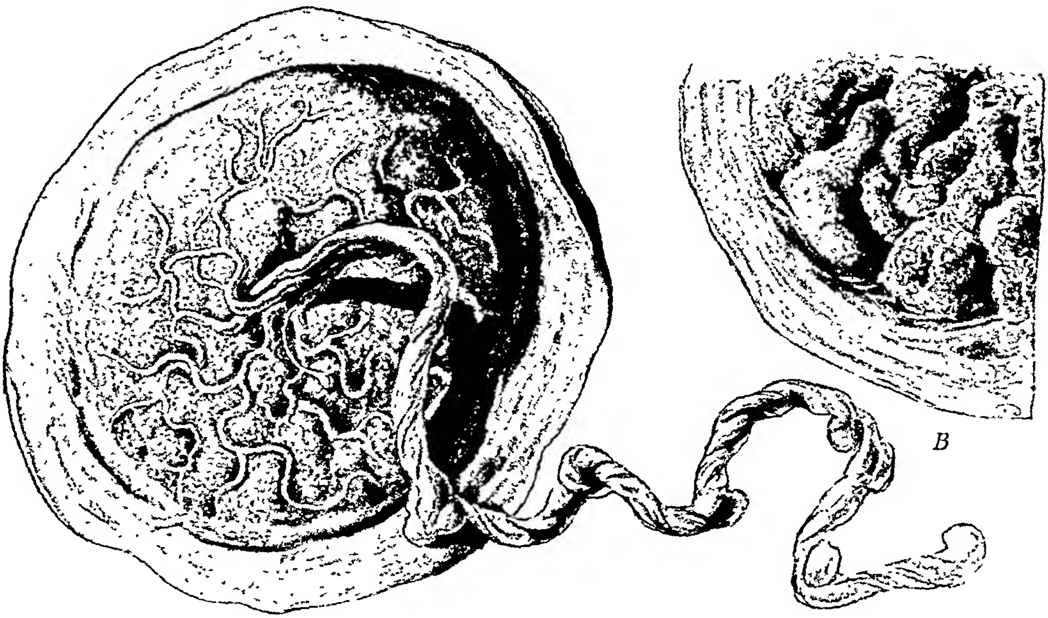
Fig. 219.—Diagrammatic section of the uterus illustrating the relation of an advanced fetus to the placenta and other membranes. (Ahlfeld.)

orrhage during the earlier part of pregnancy by acting as a dam between the chorionic villi and the eroded uterus and in this way limits the flow of blood within the intervillous space.[21] Some authorities hold that the intervillous circulation is peculiar to the second half of pregnancy. Moreover, recent studies have thrown doubt on the direct normal communication of arteries with the intervillous space, although veins do drain its contents.[20]

In this event the fluid of the space would be a lymph-like transudate, while the arterial blood, as such, circulates within intact vessels and passes through the capillary network to the venous radicles of the uterine wall.

placenta is quite common, ranging from an oval contour to other variant forms (*i. e.*, like a spindle, pear, heart, crescent or ring) which are more rarely encountered. The umbilical cord may attach atypically (Fig. 220, *A*, *B*). The placenta may be notched, lobed or even divided completely (*C*). Accessory placentas of smaller size than the main placenta are not unusual (*D*). All such specimens are referable either to growth irregularities or to the persistence and independent development of asymmetrical or multiple patches of chorionic villi. Fused placentas are sometimes found in an ordinary twin pregnancy when the proximity of implantation has led to secondary union (*E*).

The placental margin is continuous with a membrane (Fig. 221) combined from the approximation and fusion of: (1) the decidua parietalis; (2) the decidua capsularis; (3) the chorion laeve; (4) the amnion. Of these, the



B

A

Fig. 221.—Mature human placenta and its adjoining membranes after delivery (× ⅓). *A*, Fetal surface with the umbilical cord exhibiting both false knots and a true knot, and with the yolk sac remnant near its insertion. *B*, A quarter of the maternal surface of the same specimen, especially to show cotyledons. (Arey, 'Developmental Anatomy.')

decidua capsularis is no longer recognizable as such. The cast-off placenta shows an amniotic, or fetal surface and a uterine, or maternal surface. The fetal surface is primarily chorionic but, like the other deciduae, it is lined with smooth, glistening, adherent amnion (Fig. 217, *B*); in explanation of this relation it will be remembered that the chorion laeve and decidua capsularis united with the decidua parietalis at the time of the obliteration of the uterine cavity (p. 463). Usually near, but not quite at the center of the placenta is attached the umbilical cord (Fig. 221, *A*), adequately described in an earlier paragraph (p. 458). The maternal surface is irregularly rough, reddish gray in color and bears blood clots. It is incompletely divided into lobular areas which correspond to the cotyledons; these irregular *lobules* become much plainer when the septa which intervened *in utero* are split into fissures after the placenta is delivered (Fig. 221, *B*). Structurally the placenta consists

fibers which become ten times their former length,[33] but also by the transformation of small indifferent cells into new muscle fibers.[34] At the fourth lunar month the uterus has expanded until its upper end rises out of the pelvis, and at the sixth month it has reached the level of the navel; by the ninth lunar month the uterine fundus is at the lower end of the sternum, whereupon it settles somewhat. The fetus assumes a characteristic attitude in which elbows, knees, and hips are flexed, feet and arms are crossed, the back is bent, and the head is sunk on chest and turned to one side (Fig. 219). At birth the head is commonest directed downward in the mother, but the buttocks may be presented first or the fetus may lie crosswise.

Childbirth, or *parturition,* occurs on the average at the time of the tenth missed mensis following conception—that is, two hundred and eighty days after the last menstrual period. The causes that induce 'labor' are obscure, but the process consists of a protracted series of involuntary muscular con-

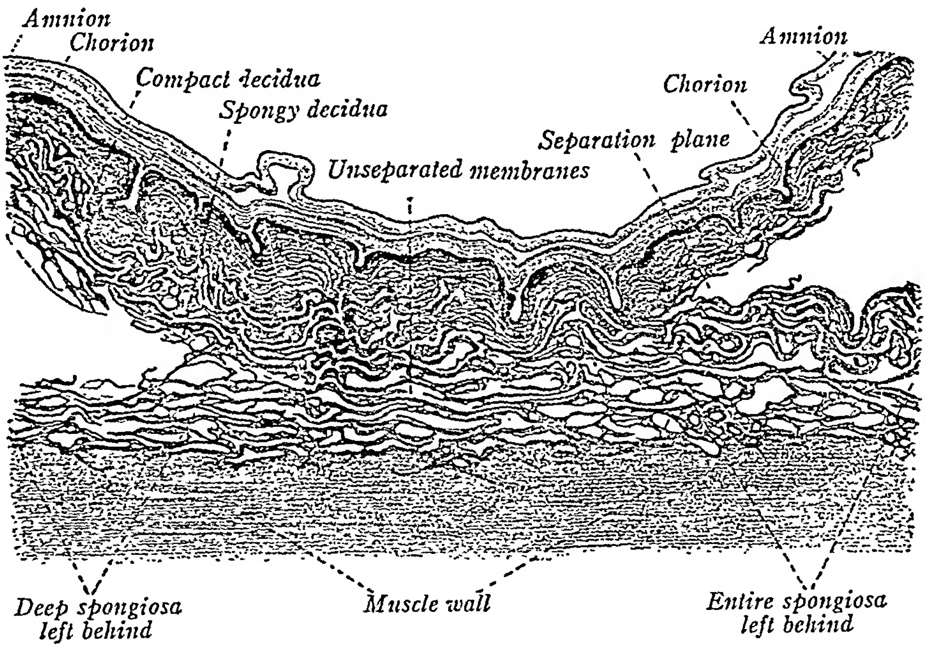


Fig. 222.—Vertical section through a partially detached decidua parietalis from a woman who died before delivery of the after-birth. A deep plane of separation is shown on the left and a superficial separation on the right. (Broman.)

tractions of the uterus, termed 'pains,' combined with reflex as well as voluntary contractions of the abdominal muscles. These bring about a dilatation of the uterine cervix, the rupture of the amnion and chorion laeve ('bag of waters'), and cause the extrusion ('delivery') of the child. With the rupture of the membranes the amniotic fluid is expelled, but the fetal membranes themselves remain behind, attached to the deciduae. Directly following the birth of the child, the uterine contractions serve also to squeeze most of the fetal blood in the placenta back into the circulation of the newborn. Within a few minutes the pulsation in the exposed cord slows, the cord is tied, and the child is severed from its mother. The stump of the cord gradually shrivels and forms a depressed scar, the *umbilicus* or navel.

The reduction in size of the emptied uterus leads to hemorrhages beneath

CHAPTER XV

DISEASES OF THE EMBRYO AND APPENDAGES

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DISEASES OF THE FETAL MEMBRANES

The Amnion.—This silvery white membrane is made up of an outer layer of mesodermic tissue and an inner layer of ectoderm. The mesodermic layer eventually becomes converted into mucoid-like tissue which does not contain blood vessels while the ectodermal layer is represented by a single layer of epithelial cells which vary considerably in shape but tend to become cuboidal. They show definite signs of secretory activity and according to Williams they may be regarded as simply an extension of the skin of the embryo. Very shortly after its formation, fluid appears in the amniotic cavity, in which the fetus is constantly bathed and which has definite characteristics. It is a clear fluid whose specific gravity ranges from 1.002 to 1.028. It has an alkaline reaction and contains albumin, fats, and certain salts.

The amount of liquor amnii varies greatly, the normal limits being from 500 to 2000 cc.

The source of the amniotic fluids was thought by Hippocrates to be merely fetal urine and this theory held almost to the present century; but recently many experimental and clinical observations have shown that the amnion is not merely a membrane, nor is it a simple filter, permitting certain substances to pass from the maternal circulation into the amniotic sac. It is on the contrary a definitely secretory tissue performing also a metabolic function. Histologically the amniotic epithelium, especially that lying over the placental site, is cylindrical, with fat globules filling the protoplasm of the cells and deposited in pockets in the underlying connective tissue. Bondi[1] has shown that the amnion cell extrudes in the form of a vacuole that material which is not needed for its own nutrition, and that this vacuole empties itself into the amniotic cavity. The direct passage of substances from the maternal circulation into the amniotic cavity, without entering the fetal circulation, has been proved by the observations of Ottow[2] in a case of sulphuric acid poisoning and by Zuntz and Wiener[3] after the injection of sodium-indigo-sulphate.

While the placental portion of the amnion is mainly concerned with fluid secretion, the free portion of the membrane is fairly rich in a variety of ferments. Polano,[4] investigating this phase of the subject, found several proteolytic ferments; a coagulation producer and a fat-splitting ferment, lipose, which according to Keiffer[5] has a definite function in the production of vernix caseosa.

Polano believed that the demonstration of these active ferments was definite evidence that the amniotic epithelium was an active, functioning

Clinical Course.—Hydramnion may be divided clinically into the rare acute variety, the more common chronic form and a third phase in which an existing chronic hydramnion suddenly presents an acute exacerbation. Acute hydramnion arising early in pregnancy may give rise to a rapid accumulation of enormous size, which occasions more or less severe pressure symptoms. Dyspnea so severe as to absolutely preclude the patient's lying down, cyanosis, edema of the lower extremities with pain in the abdomen and back may be present. The skin is tensely stretched, many striae appearing with punctate hemorrhages in the skin from excessive tension. The entire abdomen is hard and tense, fetal parts are not palpable nor are heart tones audible. There may be fever and exhaustion and a fatal outcome may ensue if the maternal heart is the seat of an organic lesion.

Diagnosis.—The diagnosis of acute hydramnion is usually simple if pregnancy is known to exist, but the condition must be differentiated from ovarian cysts, especially in connection with intra-uterine pregnancy, from ascites and from hydatidiform mole. In ovarian cyst, the enlargement is not generally so sudden, there is no history of pregnancy, and the small uterus can easily be outlined as playing no part in the enlargement, and the cervix is hard and closed. In ovarian cyst complicating pregnancy, the differentiation is much more difficult, but the demonstration of two tumors, separated from each other, should determine the state of affairs. Frequently, however, this diagnosis is missed and the condition is not made clear until after delivery. In mole pregnancy the rapid increase in size of the uterus is almost always accompanied by more or less severe vaginal hemorrhages or the extrusion of the characteristic hydatidiform cysts in the vaginal discharge, which should serve to clear up the diagnosis.

The chronic form of hydramnion offers little difficulty in diagnosis. The greatly distended uterus, the soft and patulous cervix, through which the fetal presenting part may be palpated, easy elicitation of ballottement, and the presence of fetal movements, although the heart tones are faint and distant, all serve to make the situation clear, although when the distention of the uterus becomes very great, so that the fetus can no longer be palpated, diagnosis is sometimes very difficult and hydramnion may easily be mistaken for very large ovarian cystoma.

Employment of the *x*-ray will always definitely settle the question. Excessive abdominal enlargement due to ascites may be differentiated by the characteristic movable dulness on percussion, and by the fact that on vaginal examination the uterus is found to be of the correct size in relation to the duration of the pregnancy.

Careful examination is sometimes necessary to determine whether the uterine distention is due to multiple pregnancy or hydramnion alone. The two conditions are frequently associated.

Treatment.—The treatment of acute hydramnion is active and should consist in rupturing the membranes under strict asepsis and allowing the fluid to escape gradually to avoid undue loss of intra-abdominal pressure. The patient is then left to a spontaneous abortion which almost always occurs, other active treatment being determined by special indications which may arise.

It has been clearly shown that hydramnion most commonly occurs in the presence of a deformed fetus and consequently every effort should be

2. Greater frequency among primiparas.
3. Tendency to breech presentation, in which position the fetus adapts itself more closely to the shape of the partly filled uterus.
4. Prolonged pregnancy (from twenty to thirty days overdue).
5. Long, slow labor, with frequent necessity for manual or instrumental interference.
6. High fetal mortality during and after labor.

Amniotic Adhesions.—In oligohydramnion and even sometimes when the liquor amnii is present in normal amounts, adhesions may form between the amnion and the fetus. As has been stated, when such adhesions occur early in pregnancy, great deformity results from failure of the embryo to develop in the areas in contact with the amnion.

Many instances of failure of development of the abdominal parietes, with eventration of the viscera, are due to this cause. Amputation of extremities from compression by a band of amnion have been reported, though the correctness of this view has been disputed and the writer is inclined to agree with Ballantyne[12] and Streeter[13] who believe that the so-called "amniotic amputations" are réally due to some form of trophic disturbances analogous to Raynaud's disease in later life.

For a full description of amniotic disease as a factor in teratology, the reader is referred to Ballantyne's[14] extensive discussion.

Amnionitis.—Inflammation of the amnion. During pregnancy inflammatory processes occasionally invade the amnion. They are usually associated with a deciduitis and result from preexisting gonorrhea or possibly from some invasion of the uterine cavity in an attempt to procure abortion.

Intrapartum inflammation is far more common and Siddall[15] has shown in a study of one thousand consecutive placentae from the seventh month to term, that forty-eight or 4.8 per cent showed a definite inflammatory reaction in the amnion and chorion. In seven of these placentae, bacteria were demonstrated, although in no case was there clinical or histologic evidence of gonorrhea or syphilis. It is obvious that premature rupture of the membranes permits access of bacteria to the uterine cavity with ample time for well-established inflammatory reaction before the placenta and membranes are extruded. Such inflammation will account for many instances of intrapartum fevers and serves to emphasize the necessity for scrupulous asepsis in vaginal manipulations after the membranes have ruptured. It reveals as well the inherent danger of cesarean section under these conditions.

Cysts of the Amnion.—Years ago Ahlfeld called attention to the occurrence of small cysts, lined by normal epithelium, which form in the amnion. Williams thinks they generally result from the fusion of amniotic folds with retention of fluid.

Diseases of the Chorion.—The chorion from the pathologic standpoint is a most important tissue giving origin to that bizarre term, "hydatidiform mole," and its deadly sequel, chorio-epithelioma. Those conditions will be described under "Other Tumors of the Uterus" in Chapter LXI.

DISEASES OF THE PLACENTA

Infarct Formation.—Practically all placentae if subjected to careful scrutiny will show few or many whitish, hard, nodular areas occupying the fetal or maternal surface, or both surfaces, and varying in size from the most

colored form the second class. The lighter colored masses are striated, often being made up of parallel dark and lighter striae. Infarcts of the second class are frequently surrounded by a distinctly lighter pseudocapsule and may often be found against, or partly surrounded by, infarcts of types 1 or 4. They may be seen singly or in great numbers throughout the placenta, but usually lie deep in the placental tissue and seldom near the margins. When large and numerous, the condition has been called *placenta truffée* (Fig. 224).

Microscopically, these infarcts are found to be composed of lamellae of fibrin and coagulated blood. Their color depends upon the number and state of preservation of the blood cells, the darker bodies and the dark streaks in the lighter showing densely packed and apparently unchanged red corpuscles. Sections taken at different levels show such an infarct always to be against, and in some instances partially surrounded by, a definitely older degenerative formation, usually an infarct of the fourth type, parallel to

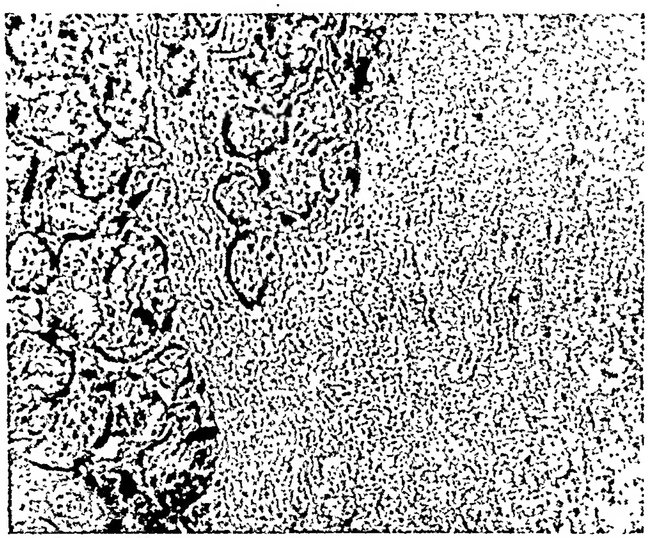

Fig. 224.—Infarct of our second kind (on right) laid down against an old infarct of the fourth kind (on left). (Siddall and Hartman in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

which the lamellae are laid down. The rest of the circumference, as well as the deeper portion, shows practically no involvement of villi. The fibrin on the free part of the periphery is frequently nearly devoid of blood cells, thus explaining the nature of the lighter colored pseudocapsule. In general, these infarcts bear a striking resemblance to fresh intravascular thrombi.

3. In the third group are striated bodies which so resemble those of the second kind in every respect, except color, that perhaps they should be included in that group. They are glistening or dull white, pinkish or definitely pink or brick colored as a whole or in streaks. In fact, infarcts of intermediate shades, with typical examples of this and the second group, are often found in the same placenta.

Microscopically, they are seen to be composed essentially of lamellae of fibrin. In infarcts of a pink hue there are a few fragmented or degenerating and pale red blood cells between the lamellae. In accord with the darker

observer states, he observed typical cases of toxemia in which no apparent circulatory disturbance was seen and, on the other hand, infarct formation with measurable circulatory arrest was noted in a number of cases in which no sign or history of such toxemia could be elicited.

The writer is of the opinion that no distinct connection can be traced between toxemia and infarct formation and has for years called the attention of interns and students to the absence of marked infarction in placentae from severe cases of eclampsia, while on the other hand, patients with perfectly uneventful pregnancies and with normal, full size babies often present such striking areas of infarction as to make the placenta an object of pathologic interest.

Cysts of the Placenta.—Small cystic areas scattered throughout its structure are very common in the placenta. These cysts are usually very small,

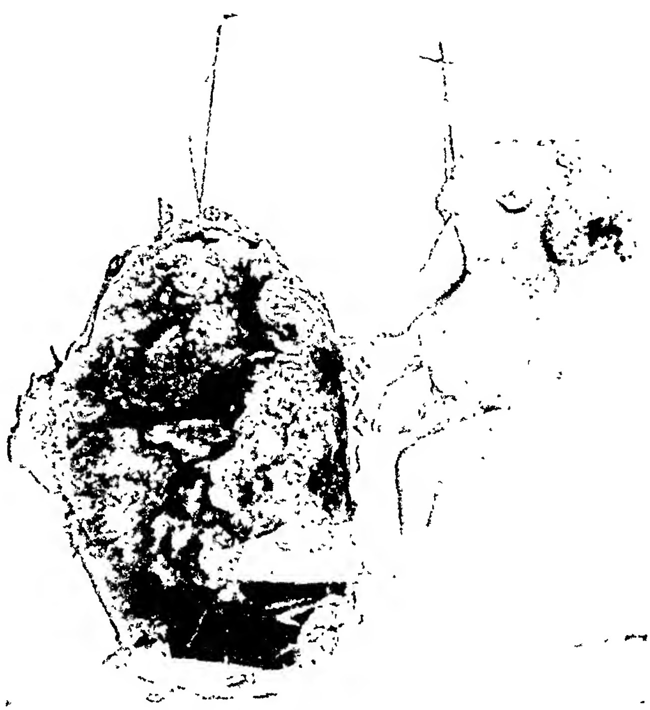

Fig. 227.—Enormous infarction of the placenta associated with craniorachischisis. (Case of Dr. F. E. Keller, Frankford Hospital, Philadelphia.)

only a few millimeters in diameter, although they may reach a diameter of 6 cm.

They are generally found in the thickest, central portion of the placenta, somewhat nearer the fetal than the maternal side of the organ. The cysts are rarely spherical, but commonly are irregular in outline, often presenting elongated diverticula; the cyst wall is a whitish fibrin band, a millimeter or less in thickness. The cavity is filled with a clear, creamy, or sanguineous gelatinous material, which may vary in viscosity from a firm jelly to a thin mucoid material.

Cysts are usually found in the decidual islands, which are normal constituents of the placenta, being portions of the decidual septa. They may

and proliferate, digesting or liquefying the tissues before them and then giving rise to the fluid contents of these cysts."

For a more detailed description of the histology of placental cysts, the reader is referred to the very comprehensive paper by Paddock and Greer, just quoted.

Clinically these structures appear to possess no significance. Paddock and Greer studied 231 cases without any conclusive evidence as to any relationship between these cysts and maternal or fetal mortality and Williams sums up the matter by saying "Cystic formation, whether occurring upon the fetal surface or in the depths of the placenta, are of interest purely from the pathologic point of view and exert little or no influence upon the course of pregnancy or labor."

Tumors of the Placenta.—All writers upon placental tumors begin by quoting the work of John Clarke[22] who in 1798 reported a case of solid tumor, the size of a man's fist, which made up a large part of the placenta. Since this publication only 131 cases of placental tumor have appeared in the literature as collected by Siddall.[23] These rare tumors take their origin from the epithelium, connective tissue, and blood vessels of the placental chorion. Their etiology is unknown, although many hypotheses have been advanced concerning them. They consist of masses of chorionic villi with immense hypertrophy and hyperplasia of the terminal vessels and hence belong to the group of chorio-angiofibromata. They are usually single, though four and six separate growths have been described in one placenta. They range in size from a few millimeters in diameter to a weight of nearly 800 Gm. They may appear on the maternal surface of the placenta, but the majority are found as firm elevations just beneath the amniotic surface of the placenta.

These tumors usually possess a pseudocapsule made up of compressed and degenerated villi. They are sharply circumscribed and are readily enucleated. In most cases the only direct connection with the placental tissue is by blood vessels entering the tumor through a small pedicle. The growths are usually single and almost spherical in shape although they may consist of a group of small, compressed lobules easily separable one from the other.

Siddall remarks that on section the surface usually gives a mottled appearance due to small darker areas separated by lighter colored septa which extends inward from a peripheral zone of fibrous tissue and carry large blood vessels. "On microscopical examination, the mass is seen to be composed of fibrous (often myxomatous) tissue, in which lie small capillaries which may be arranged in nests or diffusely scattered through the tissues. They show different degrees of dilation or may be collapsed, and their walls may be composed of single-layered or proliferating endothelium. The relative proportions of fibrous or myxomatous tissue, and vessels, may vary markedly in different tumors or in different parts of the same tumor. Degeneration and necrosis of both types of tissue have been described frequently, especially in the interior of larger tumors. Calcification and hemorrhage or blood extravasation into the tissues have likewise been occasionally mentioned (Fig. 229).

"In about one-third of the specimens there was a complete, in others a more or less perfect, epithelial investment, made up of syncytium or of Langhans' cells, or elements of both. This has been found in a single layer, or heaped up and showing evidence of active proliferation.

except for the impressive number of cases of hydramnion in the group. During the third stage of labor there may be some increase of risk from hemorrhage since in the same group of 131 cases postpartum hemorrhage and operative removal of the placenta or tumor were each reported six times and in four other cases manual removal of the placenta was necessitated by excessive bleeding (Figs. 231–233).

This frequence of hemorrhage may be explained either by the increased size of the tumor-bearing placenta preventing satisfactory uterine contraction or by the presence of the associated hydramnion, adversely affecting the contractile power of the distended uterine musculature. Occasionally hemangioma of the placenta may give rise to dystocia as exemplified in a

Fig. 231.—Section of tumor showing endothelial lined spaces about the size of capillaries but containing no blood. (Siddall in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

case reported by Emge[24] in which a tumor of 15 cm. diameter displaced the body of the fetus and caused marked obstruction to delivery (Fig. 234). This particular tumor proved to be a choriohemangioma as large as the head of the child and located entirely apart from the placenta, being extramembranous in its relation to it. A similar case is noted by Margeson[25] in which the placental tumor so prevented engagement as to demand cesarean section to secure delivery.

Effects upon the Fetus.—From Siddall's analysis of the published cases of placental tumor, one notes that of the 109 babies concerning whom information was available, 41 or 37.6 per cent perished. This high fetal mortality, upon closer analysis, is shown to be largely the result of prematurity, and this

Fig. 233.—At periphery of the tumor. *A*, Tumor; *B*, epithelium of tumor; *C*, pseudocapsule; *D*, normal villi. (Siddall in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

Fig. 234.—Chorio-angiofibroma of the placenta, associated with craniorachischisis. (Author's case.)

premature labor, is almost the rule. During the third stage there may be excessive hemorrhage as a result of deficient uterine contractions.

Malignant Tumors of the Placenta.—Such growths are very rare and so

that the presence of intravillous tubercles in the absence of syncytial lesions must be considered as strong evidence that the bacilli have passed through the syncytium without damaging it and have produced their characteristic changes first in the stroma of the villus.

Intravascular Chorionic Lesions.—This is a rare lesion, but is probably similar to the foregoing in the method of formation. In this variety tubercles form in the same manner as previously described. These lesions occur in the vessels of the chorion. The thrombi may entirely obliterate the lumen of the vessel, or may partially occlude it. They are similar in appearance to the intervillous thrombi and are deeply staining hyaline or granular masses composed of broken up chromatin. The vessel walls at the site of the thrombi often show beginning necrosis. The epithelioid cells of the tubercles develop from the vessel walls. Warthin demonstrated tubercle bacilli in these thrombi.

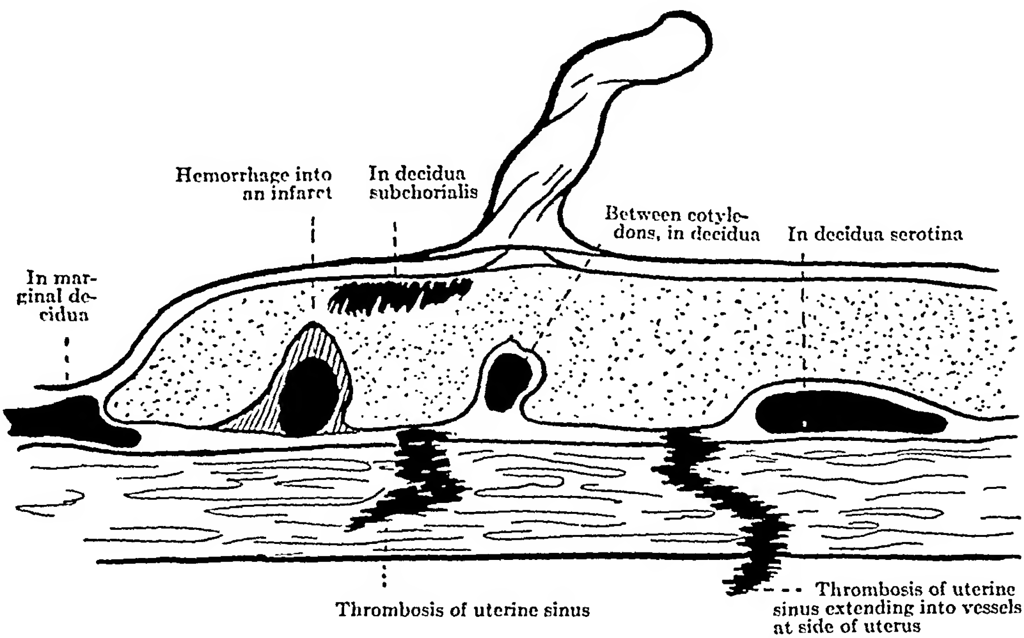

Fig. 235.—Diagram showing location of hemorrhages into placenta and thromboses. (DeLee, "Principles of Obstetrics.")

Chorio-amniotic Variety.—Warthin states that secondary involvement of the amnion by large caseating or epithelioid tubercles of the chorion was observed by him a few times. The portion of amnion in the neighborhood of the chorionic tubercles was thickened, infiltrated with leukocytes, and showed a beginning caseation. Tubercle bacilli were demonstrated in the caseous area. In one of the cases examined by Norris some of the tubercles exhibited a well-marked tendency toward healing. Healing tubercles must be differentiated from infarcts, which can easily be accomplished by noting their circumscribed shape and by the fibroplastic proliferation of the villi induced in the primary intervillous thrombus, which forms a condensed mass of epithelioid cells.

Hemorrhages of the Placenta.—Owing to the extreme vascularity of the decidua, hemorrhages are common in it. These bleedings are generally in the serotina and lead to various degrees of placental separations.

being no apparent relationship between the degree of calcification and any maternal disease. DeLee thinks that they render the placenta stiff, which facilitates its separation and expulsion, and that no portion of a calcareous placenta is ever retained.

Placenta Accreta.—Placenta accreta is a condition resulting from an entire or almost entire absence of the decidua basalis, which exposes the muscle of the uterine wall to the erosive action of the trophoblast and to penetration by the villi. This intimate union of placenta and muscle wall entirely in-

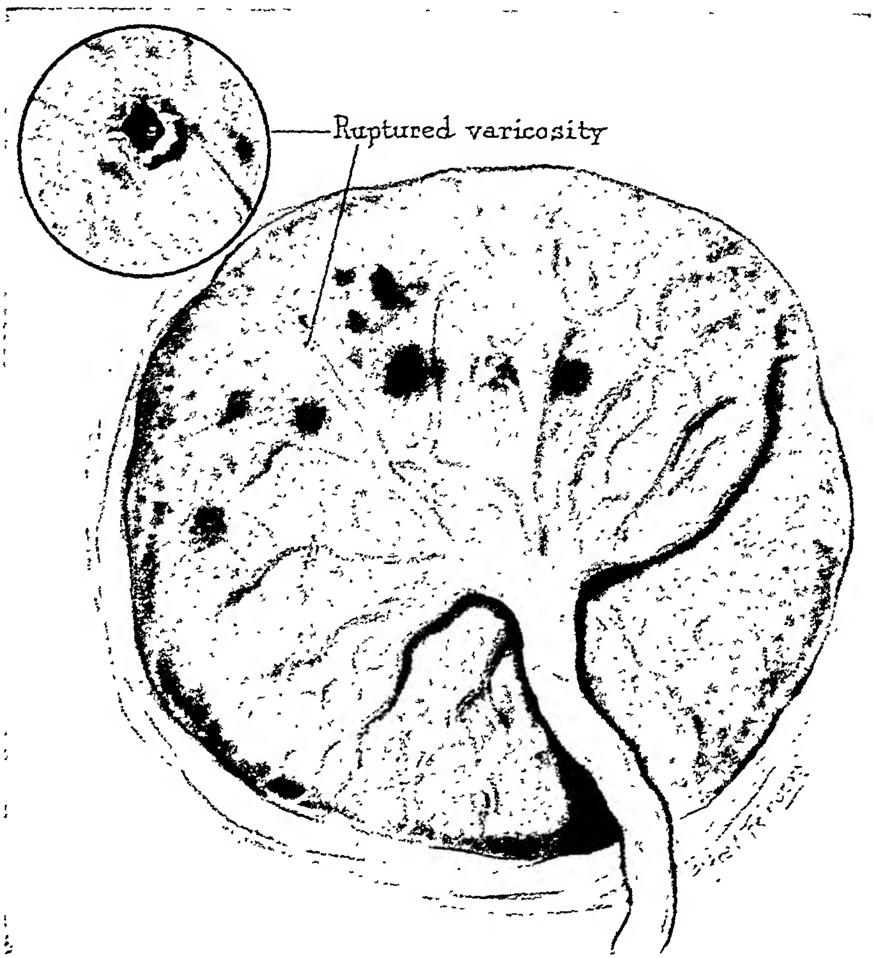

Fig. 236.—Fetal surface of placenta showing ruptured varicosity; and some blood clots under amnion. (Leff in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

validates the normal mechanism of placental separation and makes it impossible to locate any line of cleavage for such separation. The frequency of this condition has been made the subject of a number of estimates. Polak[34] places it at approximately 1 in 6000 deliveries, B. C. Hirst, 1 in 40,000. Feiner[35] collected 40 reported cases in only 20 of which the placenta was examined *in situ*. Kraul[36] described 3 cases in a total of 60,000 deliveries and Nathanson[37] reported 4 cases occurring in a collective series of 75,000 deliveries, placing the incidence at approximately 1 in 20,000. Suffice it to say, then, that placenta accreta is a rare but definite pathologic entity.

which lies next the amnion and a layer of villi which are covered by an outer layer of trophoblastic cells. As each villus grows into the basal decidua which protects the muscular structure of the uterus from invasion, it makes for itself a space by erosion into the mucosa. This space is always larger than the villus which is growing into it and ultimately forms a spacious sinus or blood space which is filled with maternal blood. Into this sinus the villus projects and becomes bathed in the maternal blood, but does not penetrate beyond the protective basal decidua. These are called the *floating villi;* others, however, opposite the funic insertion and near the placental circumference, become more deeply attached and extend further into the mucosa, and fasten the placenta to the underlying structures. These are the

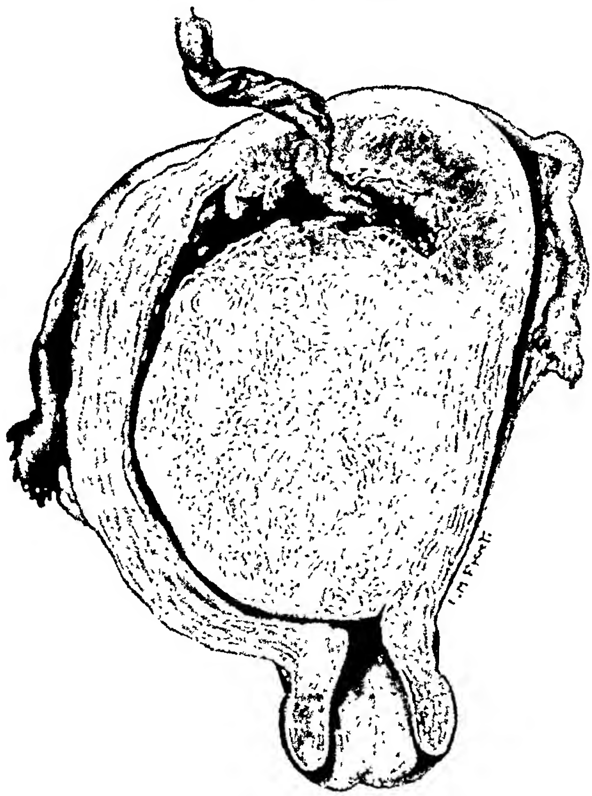

Fig. 238.—Case of placenta accreta. Implanted in uterine cornu, and on atrophic endometrium, over large myoma. (Polak and Phelan in Surg., Gyn., and Obst., February, 1924.)

anchoring villi. The protection of the muscular wall of the uterus from the diffuse erosion of these villi, covered as they are with trophoblastic cells, is due to the fact that normally there is interposed a protective layer of decidual reaction in the basalis or serotina. Certain conditions cause this protective layer of endometrium to be absent or atrophied. This permits the villi to erode themselves into the muscular wall of the uterus and even penetrate through the uterine muscle. This fetal cell invasion so weakens the uterine wall that perforation is easy; the placenta and myometrium become a continuous inseparable mass (Figs. 237, 238).

That the presence of a normal decidua basalis is necessary for placental separation is easily seen by a brief review of the *mechanism of the normal*

themselves into the muscle fibers, with a resulting degeneration and thinning of the uterine wall, even to the point of rupture. Indeed, in a case reported by Tennant,[38] the placental villi not only penetrated the serosa of the uterus, but actually invaded the abdominal cavity. On examining a uterus, the seat of placenta accreta, the musculature over the placenta is seen to be relaxed and thin, even perforated in some cases by chorionic villi. There is no line of demarcation between placenta and uterus and attempts at separation result only in the tearing of fragments of placenta out of the uterine wall.

Microscopically, the decidua basalis is entirely absent, the villi directly entering the uterine muscle and generally there may be demonstrated groups of syncytial cells in and between the muscle fibers, while other masses of these cells split the uterine wall into ragged fragments.

Clinically, placenta accreta must be distinguished from: (*a*) retained separated placenta and (*b*) simple adhesion of the placenta. Retention of the separated placenta is characterized by uterine bleeding, descent of the

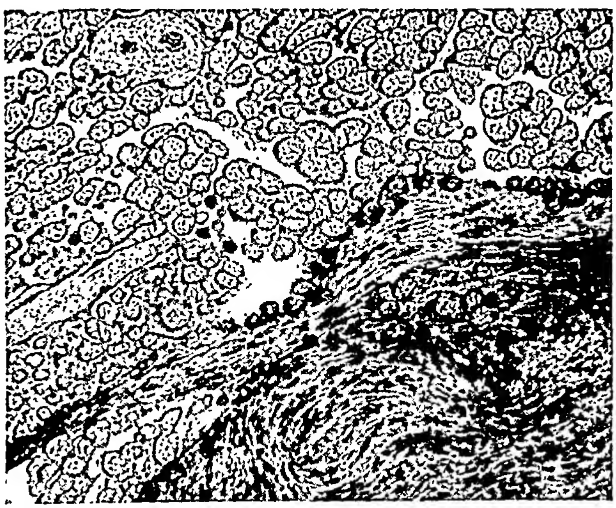

Fig. 240.—Placenta accreta. Invasion of syncytial cells into the muscle wall. (Polak and Phelan in Surg., Gyn., and Obst., February, 1924.)

cord and the typical globular contour of the uterine fundus. In simple adhesion and in placenta accreta, there is no uterine bleeding, since the retroplacental blood spaces remain plugged by the placental villi. There is no descent of the cord, and, according to Polak (*q.v.*), the fundus assumes a characteristic shape, being broader from side to side and intermittently relaxed, but assuming the firm contraction and ball-like shape present when the placenta has separated.

Simple adhesion cannot be differentiated from placenta accreta except by attempts at manual removal. If the former condition be present a distinct line of cleavage will readily be found and complete separation may be attained by the exploring fingers, whereas, if the adhesion be due to an accreta no cleavage is discovered and attempts at manual removal result only in piecemeal extraction of ragged portions of the placenta with intractable hemorrhage.

The diagnosis of adherent placenta, whether simple, or due to an accreta,

supravaginal hysterectomy, since by this procedure only can the excessive mortality from sepsis and hemorrhage be avoided.

Abnormalities of the Placenta.—The normal placenta is a flattened disk, varying from 15 to 20 cm. in diameter and from 2 to 3 cm. in thickness. In the later months of pregnancy the placenta may vary considerably in size and exhibits also many abnormalities in its form. Occasionally the placenta is divided into several parts which may be entirely distinct or more or less closely united. This phenomenon may be an atavistic form since the placenta of many of the higher apes is always double though but a single fetus is present. Rarely the placenta may be roughly rectangular in shape with an aperture near the center, this variety being termed *placenta fenestrata*. Sometimes the organ is composed of several lobes, *placenta bipartita* when there are two divisions, and *tripartita* when there are three. Rarely there are a number of small lobes, their vessels uniting to furnish the adequate blood supply for the fetus, as many as seven small lobes having been described. Sometimes

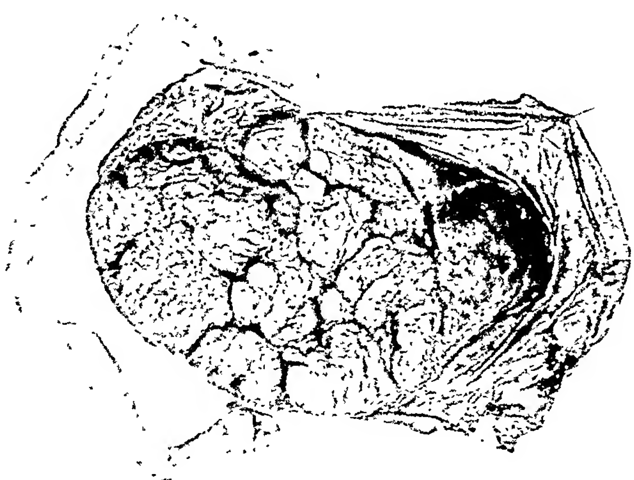

Fig. 242.—Placenta succenturiata. (Author's case, Kensington Hospital for Women, Philadelphia.)

the cord, usually inserted near the center, is attached to the very margin of the placenta, the so-called "battledore placenta." These variations in form have no clinical significance (Fig. 241).

Placenta Succenturiata.—In this anomaly one or more accessory lobules are developed in the membrane at a greater or less distance from the margin of the main placenta. Usually these accessory lobules are connected to the placenta by their blood vessels but occasionally they are entirely separate and distinct (Fig. 242). This form of placenta occurs about 1 in 500 deliveries and if, as is usually the case, the accessory lobule is expelled with the main organ it has no clinical significance, but should it not be so expelled, rather serious complication may occur. First, there may be immediate postpartum hemorrhage from rupture of the vessels between the accessory lobule and the main placenta. Second, the accessory lobe may remain in the uterus and give rise to marked delayed hemorrhage. Third, by its retention the accessory lobe may occasion sepsis. The diagnosis of placenta succenturiata may always be made if the extruded placenta be closely examined. If evidences of a torn

been recorded, while rarely it may be so short that the abdomen of the fetus is in contact with the placenta, but under such circumstances a congenital umbilical hernia is always present.

Too long cords have no clinical significance other than their tendency to prolapse or to coil about portions of the infant.

Short umbilical cord may give rise to severe dystocia and constitutes a very definite peril to the infant intra partum. From the clinical standpoint short cords are divided into the absolutely short, 32 cm. or less in length, and the relatively short, 35 cm. in length. To these must be added the shortened cord, which, originally of normal or even greater length, has been shortened by looping or coiling about parts of the fetal body.

Gardiner[42] who has deeply studied this subject states that in a vertex presentation the placental insertion of the cord must not be farther than 5 cm. above the superior strait in order that the fetus may be born without traction, and the cord must be 32 cm. in length. In a breech presentation, in order that the fetus may be born without cord traction, the cord must be 55 cm. in length. In a vertex presentation with a loop of cord about the neck, the cord must be 76.50 cm. in length, if birth is to occur without traction. In a vertex presentation with a coil of cord about the neck, a length of 93.50 cm. is required. In a breech presentation with a loop of cord about the neck, the cord becomes a spiral and very little needs to be added to its length. In a breech presentation with a coil of cord about the neck, a length of 101.50 cm. is necessary if undue traction is to be avoided.

Gardiner arrived at these figures by a series of measurements from the fundus to the vulva before and after the birth of the head, or breech. This author has collected statistics which lead him to the conclusion that a coiled or shortened cord occurs once in every 5.5 births. In a later article, Gardiner[43] found a cord complication of some sort in one of every 3.5 births.

Adams[44] found short or shortened cord in 16.9 per cent in a total series of 604 consecutive deliveries.

The etiology of coiling or looping of the cord about the fetus is not clear, but it seems reasonable that fetal movements in the presence of an abundant supply of liquor amnii plus the spiral vermicular movement of the cord itself are chiefly responsible.

Clinically the short cord is important because traction upon it may cause prolonged delay in the second stage, may cause fetal asphyxia, or, rarely, may produce either premature separation of the placenta or spontaneous intra-uterine rupture of the cord itself, several cases of which appear in the literature. Inversion of the uterus and umbilical hernia of the fetus may also develop. False labor pains are also attributed to short cord, as are malposition of the fetus, notably transverse positions.

The chief symptoms of insufficient length of the cord are delayed second stage of labor and a slowing of the fetal heart tones. Treatment consists in prompt delivery by the best available means, with regard to the degree of descent and the character of the cervix as to effacement and dilatation.

Variations in Insertions of the Cord.—The umbilical cord is usually inserted eccentrically upon the fetal surface of the placenta, nearer the center than the periphery, while a truly central implantation is less common. Occasionally the insertion is at the margin of the placenta, the so-called "battledore placenta" (*q.v.*). Williams gives a series of 2000 placentae examined as to

phyxia. Cases are recorded wherein the torsion was so marked as to almost divide the cord, a thin pedicle alone uniting the ends.

Diagnosis is impossible except that a suspicion of late torsion may be aroused, should the fetal heart rate change in character rather suddenly during the latter weeks of pregnancy. The only suggested treatment is prompt delivery if any form of cord obstruction is suspected.

Knots of the Cord.—True knots of the umbilical cord are said by some writers to occur quite frequently, but Browne regards them as uncommon. He quotes von Winckel as stating that they are present in 0.4 to 0.5 per cent of all births. These knots have been held to be developmental anomalies, but modern opinion holds that they are due to the movements of the fetus, causing it to pass through a loop. and most frequently occur early in labor.

Fig. 244.—Product of conception complete after delivery. White marker indicates site of rupture in the varix. Maceration of the child's skin may be seen. Note infiltration of the cord and fetal surface of the placenta with blood. (Adair and McDonald in Amer. Jour. of Obst. and Gyn., June, 1929, published by C. V. Mosby Co.)

Very long cords and some degree of hydramnion are contributing factors in knot production. When knots occur late in pregnancy or during labor, they are of no clinical importance, rarely becoming tight enough to interfere with the circulation, but should they develop during the early months, they may gradually be drawn so tight as to produce fetal asphyxia and death. Browne collected 26 cases of this accident.

False Knots of the Cord.—Occasionally piling up of the jelly of Wharton into irregular masses along the course of the cord gives rise to little nodules which are called false knots. Since the vessels of the cord are longer than the cord itself, they may become folded upon themselves, also giving rise to nodulations which are designated as false knots. These conditions have no clinical significance.

comes inflamed after premature rupture of the membranes, in the presence of intra-partum fever, and in leukocytic infiltration of the placental chorion and amnion. Siddall[50] made a study of one thousand cords from consecutive deliveries and found inflammatory reactions in 6 per cent. Both ends of the cord were usually affected but the intensity of the changes were greater at the placental end and in the umbilical vein. The lesions were usually leukocytic and small round cells infiltrated the vessel walls and the adjacent connective tissue. Siddall believes that inflammation of the cord occurs most frequently in the absence of syphilis and is, therefore, of little value in the diagnosis of this disease.

The immediate prognosis for the child is not affected by the presence of such inflammation.

DISEASES OF THE DECIDUA

The decidua may be affected by a variety of inflammatory lesions, all of them prototypes of more or less similar changes occurring in the nonpregnant endometrium, most of them being simply continuations of an inflammatory process present before conception occurs. Occasionally such inflammation may originate during pregnancy, especially where criminal abortion has been unsuccessfully attempted.

True endometritis is usually associated with sterility. Although minor disturbances of the endometrium may not interfere with conception, abortion, placenta praevia and other abnormalities are frequent sequels of conception occurring under these conditions.

Diffuse Thickening of the Decidua.—Under this term Williams describes a generalized hyperplasia of the decidua, in which, as pregnancy advances, this structure becomes much thicker than normal and is exceedingly vascular. Areas of hemorrhage are present, there is always more or less degeneration, and microscopically there is considerable round cell infiltration. Sometimes the hypertrophy occurs in isolated patches, giving rise to irregular polypoid projection of the decidua and hence called by Virchow *tuberous* or *polypoid endometritis deciduae.* Certain writers consider this a common lesion and Williams quotes Nyulasy[39] as reporting 100 cases in his own practice. Williams himself, however, had never seen a case, nor has the writer.

Glandular Hyperplasia of the Decidua (Endometritis Deciduae Glandulare).—This condition occurs when the uterine glands are hypertrophied and increased in number, the ducts usually remaining patulous. It results in a more or less profuse yellowish discharge (the endometritis deciduae catarrhalis of Schroeder), the amounts varying up to 500 cc. as reported by Ahlfeld. The continued secretion prevents the union of the vera and the capsularis, which remain separated during the entire pregnancy. The discharge has been termed *hydrorrhea gravidarum.*

Atrophic Endometritis Deciduae.—Certain writers have described a condition in which large portions of the decidua vera and capsularis undergo atrophic change, similar to that which normally occurs outside the placental site after the third month. Very little is known of this condition or its clinical effects.

Acute Endometritis Deciduae.—The decidua may suffer infection by the gonococcus, or by the pyogenic bacteria which gain access to the uterine cavity in attempts at criminal abortion, sometimes by coitus with a patulous cervix.

after delivery or abortion thorough curettage should be performed in order to excise every portion of the infected endometrium.

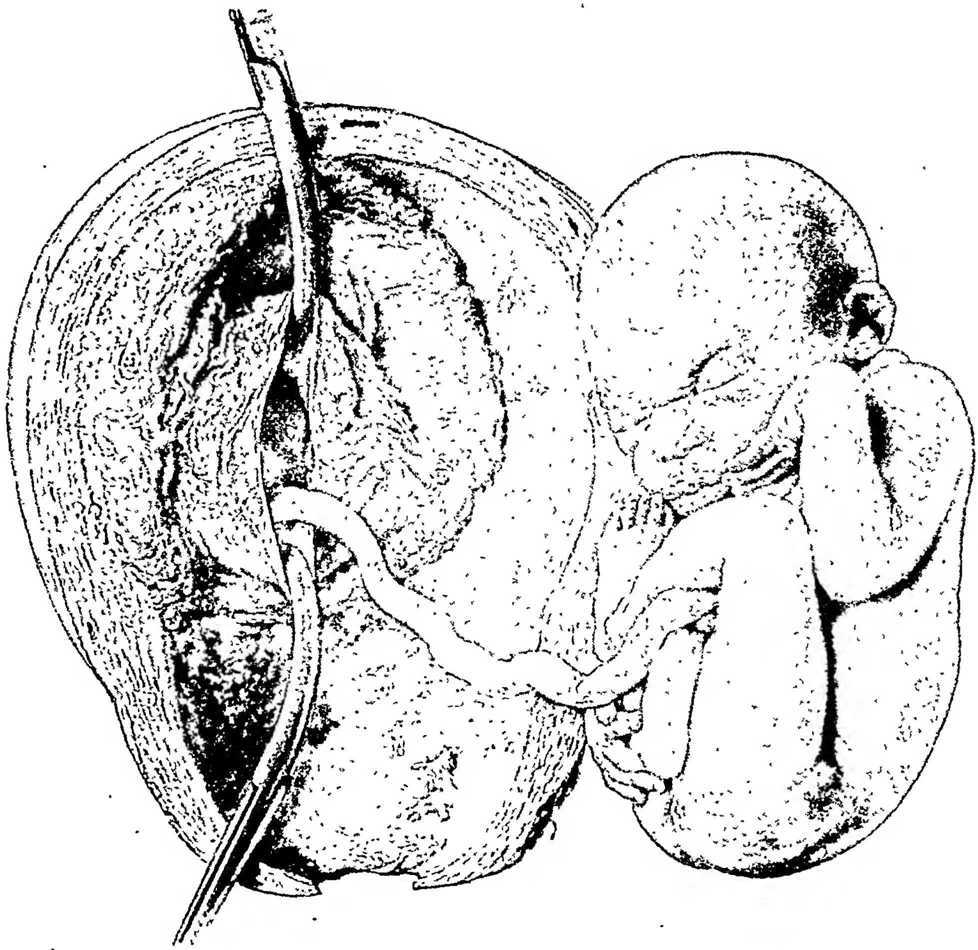

Fig. 247.—Extramembranous pregnancy. Note collapsed fetal membranes held apart by clamps (× $\frac{3}{5}$). (Hofbauer.)

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CHAPTER XVI

ANATOMY, PHYSIOLOGY, AND PATHOLOGY OF THE FETUS

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(A) THE ANATOMY AND PHYSIOLOGY OF THE FETUS

The anatomy of the fetus, as well as its physiology, is in large measure that of the adult, there being, however, several striking points of difference. The most important of these, the fetal circulation, has been described at length in another portion of this work, as has the morphology of the embryo in the early weeks.

His has divided antenatal life into three periods, that of the ovum including about the first two weeks, the embryo covering the next three weeks and the fetus beginning with the sixth week. At this time the fetus shows evidences of human form with cephalic development, limb formation, primitive vascular system and "anlagen" for all organs. There is a beginning of skeletal development with the deposition of an ossification center in the clavicle. The cephalic portion is rather disproportionately large, and by the end of the second month there is well-marked flexion with extremities showing recognizable hands and feet, legs and forearms, thighs and arms. The external genitalia are evident and the fetus has a length of 2.5 cm. The fetus is mostly fluid with little albuminoid material and a negligible amount of ash.

The mineral composition is interesting in that the percentage is practically constant at all ages in terms of body substance. It can be readily understood that maintenance of a proper balance is important not only for the fetus but also in its relation to the maternal tissues. It would be inconceivable that the embryo and fetus could exist and develop with any disturbance of the osmotic or acid-base equilibrium between itself and the mother.

The mineral metabolism is closely related to skeletal development, which begins with the deposit of various ossification centers during the second month of fetal life. Transmission of minerals takes place by osmosis through the fetal chorionic cells, lying between the fluids of the mother and the fetus.

The skeletal development of the fetus is an index of age and growth and is directly related to fetal size. The size and pliability of the bones of the fetal head are of interest to the obstetrician as the principal anatomical factors pertaining to the fetus which produce difficult labor. The development of the bony pelvis, which is of interest to the obstetrician, has been considered in a previous chapter.

All bones except the membranous bones pass through three stages of development: (1) The blastemal; (2) the chondrogenic; (3) the osseous. In the membranous bones the second stage is omitted. The methods of studying the deposition of these ossification centers are by microscopical examination, by transparent specimens, and, most important, by roentgenograms, which are more frequently available and which reveal not only the normal but also some of the abnormal conditions. The *x*-ray method can also be

maticomaxillaris; (18) sutura intermaxillaris, and (19) sutura zygomatico-frontalis.

An x-ray of the fetal skull at term shows a marked degree of enamel formation of the temporary teeth. This formation begins during the fifth fetal month, and the enamel of the first permanent molar appears in the last month of fetal life.

There are certain head measurements which are of considerable importance in obstetrical practice, as they are more or less proportional to the normal female pelvis and must be understood in their bearing upon the mechanism of labor.

The accompanying drawings show the contours of the skull and some of the various measurements (Figs. 248, 249). Only those of the skull at the time of birth will be given. The diameters of the greatest significance are the (1) fronto-occipital (F. O.), which extends from the nasion to the most

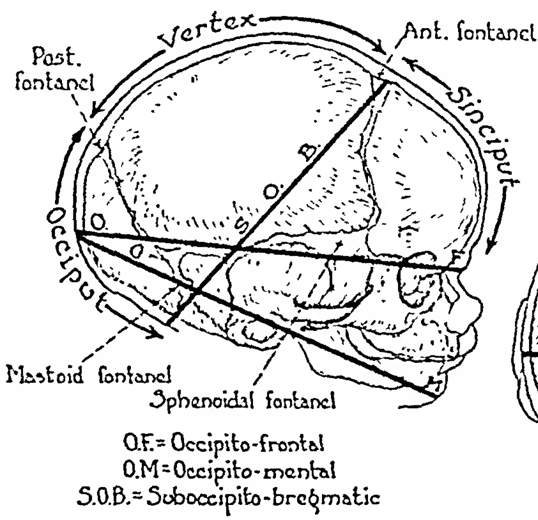

Fig. 248.

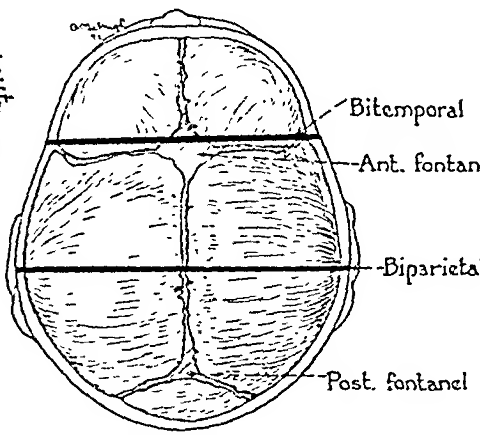

Fig. 249.

Figs. 248, 249.—Skull of the newborn child showing fontanels, sutures and diameters.

prominent part of the os occipitale; (2) the mento-occipital (M. O.), which is represented by a line drawn from the last-mentioned point to the median point of the chin; (3) the suboccipitobregmatic (S. O. B.), which extends from the suboccipital part of the occipital bone to the midportion of the large fontanel; (4) the biparietal diameter (B. P.), which lies between the parietal bosses; (5) the bitemporal (B. T.) runs between the outermost parts of the temporal bones.

The circumferences of the head of the greatest obstetrical significance are the largest and the smallest. The former is represented by the transverse plane passing through the fronto-occipital diameter (F. O. C.), and the latter by an analogous plane cutting through the suboccipitobregmatic diameter (S. O. B. C.).

The following table is compiled from data given by Williams, Scammon, and Calkins, and Sellheim (Halban and Seitz), Bumm, and DeLee. All measurements are given in centimeters.

avoided if possible and the needful bowel activity obtained by vegetables and fruits which will leave a residue in the bowel. In addition to this mineral oil may be used. This functions as a harmless liquid foreign body rather than as the lubricant which it is usually supposed to be. Some of the preparations now obtainable, to which agar has been added, appear to be of greater value than the clear oil. The amount may be varied in different cases. Some women will obtain considerable benefit from a single dose of from 2 teaspoonfuls to a tablespoonful at night while others find it better to use it morning and evening or after each meal. The amount may be varied according to need.

It must be remembered that an adequate amount of water must be taken. When an insufficient quantity of water is drunk, the contents of the lower bowel become dry, claylike masses which are difficult for the bowel to move. Enough water must be taken to supply the normal physiologic needs of the body and, in addition, to cause the contents of the lower bowel to be of a butter-like consistency. If nausea is present, as may be the case in the early weeks of pregnancy, it may be difficult for the expectant mother to take the necessary amount of water, and, indeed, to take the foods which will be of greatest service. In this event cathartics may be needed, but their use should be limited as much as possible.

Should dietary regulation together with the use of mineral oil be insufficient to correct the constipation, it may be relieved by the use of small retention enemas of oil, which should be taken at night. The enema may most simply be given through a small rectal tube or large rubber catheter to which may be attached a funnel about 4 inches wide, which may be obtained from any hardware dealer. The tube is introduced approximately 4 inches into the bowel, and 3 ounces, about one half an ordinary tumbler, of warm oil is allowed to run in. This is permitted to remain until morning when an attempt to move the bowel is made. The enema will often soften hard masses and thus promote evacuation. Should this means of producing regular evacuation need to be repeated several times a cheap grade of salad oil, which is usually cottonseed oil, may be procured from a grocer which will serve the purpose quite as well as the more expensive olive oil of the pharmacist. If this maneuver is combined with the dietary regulation mentioned above the enemas may often be discontinued after a time.

Should colitis be present the collaboration of an internist may be of help. In any event the formation of a cathartic or enema habit should be prevented.

In occasional cases, particularly toward the end of pregnancy, the careful use of cathartics may be needed for a time. The gentler drugs, as phenolphthalein and cascara, may be used; the more drastic ones, such as salines, should be avoided.

Douches.—Vaginal douches should be discontinued in pregnancy, except when indicated by the presence of certain vaginal infections. The treatment of these conditions will be discussed elsewhere.

Any existing leukorrheal discharge may be aggravated by the pelvic congestion incident to pregnancy, and occasionally this may annoy the woman to such a degree that she may insist upon the use of a douche. When this occurs, she should be advised to use a warm—not hot—douche at a low pressure, the douche can or bag being only about 18 inches above the body.

The table on page 520 gives an indication of the growth of the fetus in length and weight. The tabulations are made up from Williams' table, which is based on data from Streeter, from the work of Scammon and Calkins on "Growth in the Fetal Period," and from Dietrich's contribution in Halban and Seitz. All measurements are given in centimeters.

There are many factors which affect fetal growth, among which may be included those of inheritance. It is very probable that either maternal or fetal hormones play a part in fetal growth as a whole and also in the development of parts and organs. The nutrition of the fetus is very important in determining its size. It is not known just how much the development of the fetus can be influenced by the maternal diet but probably not to any great extent unless the mother is placed upon an actual deficiency regimen. There are other factors of definite importance, such as the implantation process. It has been shown by Adair and Thelander that there is a definite relationship between the size of the placenta and the size of the fetus. Another factor is the condition of the placenta, which frequently is the site of retrogressive changes. One cannot tell just what the margin of safety in the placenta is, but one author has seen a few cases in which a small fetus was born, apparently at term, in which half of the substance of the placenta appeared degenerated. It seems probable that a decrease in the size of the functioning placenta would curtail the food supply of the fetus and result in the birth of a smaller infant. The functioning placenta may suffice up to a certain point of fetal life and be insufficient thereafter, and lead to the intra-uterine death of the fetus. The same result would follow from a progressively degenerating placenta. These local processes which interfere with fetal growth and development may therefore lead to the intra-uterine death of the fetus or to the birth of a small and immature infant. One should distinguish between an immature and a premature fetus. They are physiologically different even though of the same size. The former is functionally more mature than the latter and, other things being equal, will thrive much better in extra-uterine surroundings than the premature infant. The condition which stunts or destroys the fetus is probably a placental deficiency or insufficiency. This is well illustrated in twin pregnancies in which one fetus receives the larger blood supply from the major portion of the placenta. The one whose vascular system is connected with the smaller portion of the placenta may be smaller than its mate and may even succumb. Occasionally one finds a fetus papyraceus or compressus which has developed in this way.

Fetal gigantism, with the infant exceeding 5000 Gm. in weight, occurs occasionally and may cause serious dystocia. Such cases are often difficult to diagnose and present serious problems at the time of delivery. These fetuses are often killed by injuries received at the time of birth. Mutilating operations are necessary in some cases.

(B) DISEASES OF THE FETUS: ANTENATAL PATHOLOGY

Observation, speculation and study of monsters and of gross developmental errors have occupied the minds of men from the beginning of recorded facts, but until comparatively recently (the work of Geoffroy-Saint-Hilaire appeared in 1837), observations have been cursory, the studies negligible, and speculation an absurd mixture of medieval superstition and biological

tionship are fairly common. Some factors of a hereditary or of intragestational origin may interfere with osteogenesis and produce resultant skeletal defects which lead to the formation of an abnormal pelvis. Such a process may not be of importance to the health of the infant, child or adult, but may lead to a pelvic anomaly with contracture sufficient to seriously complicate parturition, and imperil the life of infant and mother.

These examples of the close interrelationship of antenatal pathology to postnatal conditions might be multiplied indefinitely. Suffice it to say that its ramifications extend into every department of medicine to a greater or less extent.

Antenatal life, though occupying so comparatively short a time, is so intensive, and is made up of so many almost conflicting factors, that for a proper understanding of its biology it must be divided and subdivided into periods which will correspond with the particular character of the phenomena occurring during these divisions of time. Here we have closely followed Ballantyne, whose description of antenatal physiology can scarcely be improved upon.

First, there is the germinal period, not truly a portion of intra-uterine existence, since it reaches back to the independent existence of the ovum and the spermatozoon, but of the greatest importance in that herein lie all those mysterious forces, transmitted potentialities and characteristics, both dominant and recessive, the sum total of which we call heredity. Next, we have the short and hazy period of conception, first when both mature ovum and spermatozoon have been deposited in the cavity of the tubes and lie apart, and, second, when impregnation has taken place and the blastodermic vesicle is forming. Then follows the important embryonal epoch, beginning with the formation of the primitive streak and including the first six weeks after conception. It is during this short time that the groundwork and plan of the mature fetus are laid down. Organogenesis is its most essential feature. The cellular basis for future organs is now established, and it is during this embryonic period that the more gross malformations and terata are first noted. Arrest of development during this time leads to marked abnormalities, frequently of a character incompatible with life, fetal death and maternal abortion being a natural sequence. It is during the embryonal period that the forces concerned in the inheritance of physical characteristics become operative, and at this time are established those transmitted peculiarities which are inherent in the germ plasm and the chromosomes of the ovum or spermatozoon and may lead to tissue and organ defects (Fischel).

It has been clearly shown, too, that terata may be formed during the embryonal period by a faulty implantation of the ovum due to some external influences which interfere with the nutrition of the embryo. Mall, working with human embryos, the products of spontaneous abortion, reached the conclusion that the power to become a monster is present in every ovum, provided the conditions surrounding the ovum be inimical to normal development.

This very important generalization runs parallel to that of Hertwig, who, after an elaborate experimental work upon the production of spina bifida in frogs' embryos, by the use of a solution of sodium chloride, made the statement that any human ovum may become a monster, either anencephalic or otherwise, and that this is not necessarily due to any abnormal condition of the germ, but to external influences which affect the growth of the egg.

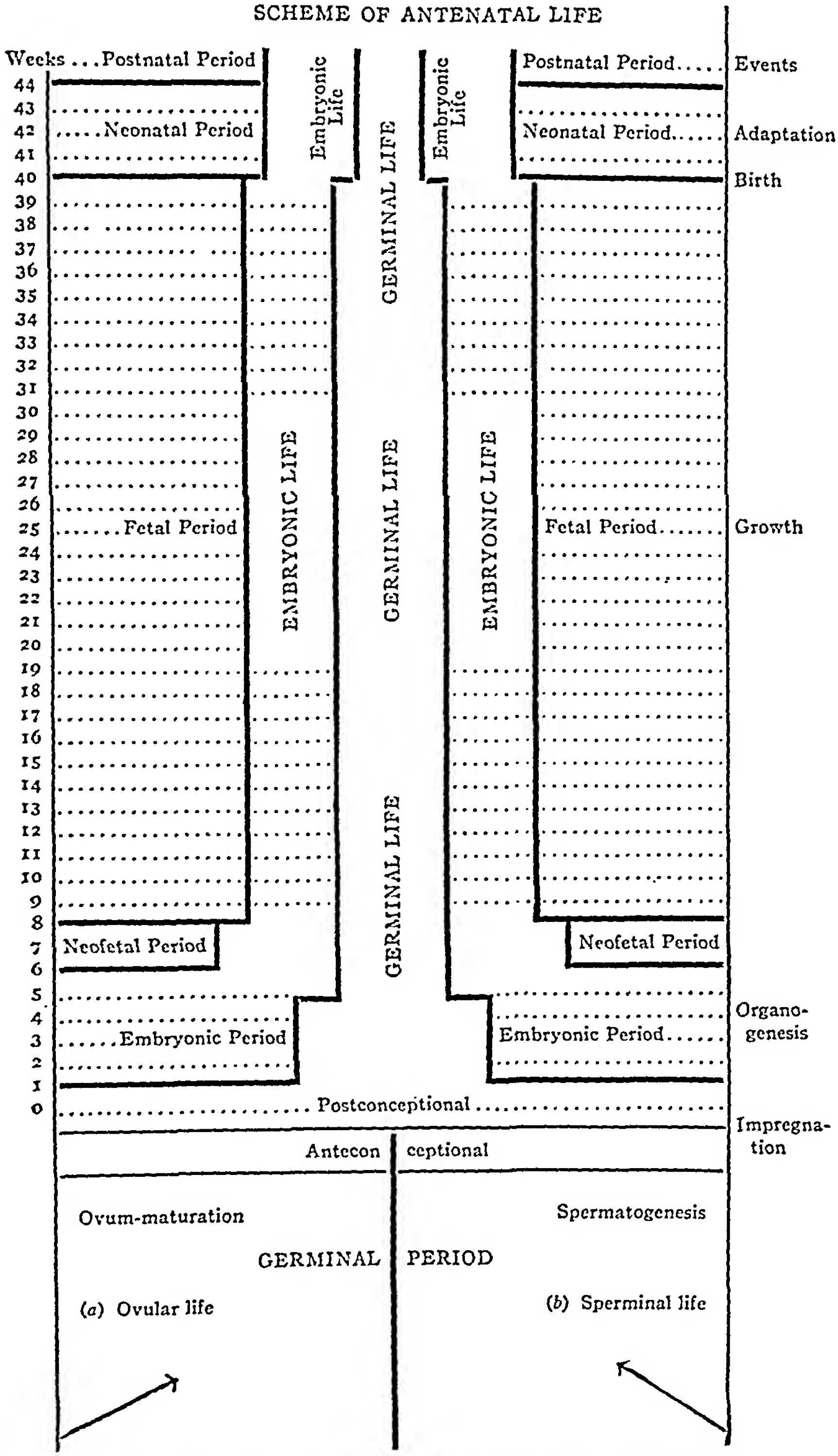

Fig. 250.—Chart showing scheme of antenatal life. (Ballantyne.)

of the variations in the temperature of the surrounding medium; and the respiratory and digestive tracts are becoming orderly parts of that wonderfully synchronized instrument, the human being.

The chart (Fig. 250) from Ballantyne graphically illustrates these divisions of antenatal life. Such arbitrary divisions of intra-uterine life are, of course, impossible, and the second chart (Fig. 251) is a more graphic representation of what actually occurs. It will be seen that the organogenesis of the embryonal period continues and extends through all subsequent divisions of antenatal life, and indeed, if the chart were extended, would continue until the third decade of postnatal life, as has been suggested by the late development of the sexual apparatus, the bones and some other structures.

Germinal factors also extend through the succeeding epoch of life, providing for the continuity of the germ plasm, growth, however, being the main factor. Having thus outlined the salient features of the great division of antenatal existence, we may turn to the characteristic pathologic changes which may occur in these several periods, and here, as is to be expected, the pathology follows closely the nature of the biological processes, conforming to the corresponding period; or, in other words, the nature of antenatal pathologic processes parallels the synchronous normal physiologic activities of the fetus.

At the very beginning, we have, then, the ovum and the spermatozoon, lying separated within the cavity of the tube, and here the pathology is that of these isolated elements, or that of the germs.

Herein become operative all the principles of heredity, and of the transmission of inherited and perhaps acquired characteristics, all of which is beyond the scope of this article. It must be said, however, that knowledge of the inherited characteristics of any race of civilized man is imperfect. The history of breeding laws, sexual selection as opposed to mating on the basis of the expediencies of community life, and so on, is so vague and fragmentary that no accurate generalizations can be formulated. Even the mathematical progressions of Mendel fail in the case of man, by reason of his hybrid and unknown ancestry. It is here that the science of eugenics fails of its purpose, for in order to produce desirable and desired results by mating and crossing of types, there must be some knowledge of the genealogy of the subjects, a matter entirely wanting among mankind. The germinal pathology, then, consists of the morbid transmitted characteristics and tendencies.

The pathology of the embryonic period next concerns us, and here, following the rule, the physiology of the embryo must be recalled in order to understand its pathology. The vital activities of the embryo have been stated to be mostly constructive, being concerned with the laying down of organs and systems of organs with function in most cases appearing later, and with morphology and the specialization of cell groups as the chief factors. The pathology of this period would then obviously be one of disturbances of morphology, abnormalities of form and structure—in a word, the formation of terata. It is during the six weeks or so of embryonic life that monsters are produced, though it must be understood that the factors involved in germinal pathology may also carry through that stage and directly influence the eccentricities of structure which then occur.

The mechanism of monster formation and the theories regarding it form one of the most fascinating chapters of medical research, and its last word still remains to be written in the far distant future. Out of the maze of the-

tial differences due to the several factors which differentiate the fetus from the infant.

The intra-uterine environment is the first of these factors to be recognized. During its entire prenatal life, the fetus is immersed in a fluid medium of unvarying temperature which plays a somewhat debatable rôle in its nutrition, and also serves as a protection against traumatisms, against alternations of heat and cold, and against the invasion of the tissues by bacteria. As examples of the influence of this environmental factor may be mentioned the difference between the pustules of variola in the fetus and in the infant, the rarity of wounds and fractures, except when the latter are a result of amniotic adhesions, and many others. Second, there is the enormously important placental influence, which differentiates prenatal from postnatal life. It must be remembered that the fetus is truly a parasite, obtaining its nutriment and the materials for its growth solely from the maternal tissues, and these largely through the medium of the placenta. Inasmuch as fetal existence depends almost entirely upon the mechanism of the placental circulation, it is possible for an embryo so malformed as to be entirely incapable of a moment's extra-uterine life, to reach its full term of intra-uterine development entirely undisturbed. Complete atelectasis may exist, the kidneys may be mere thin-walled cysts with no secreting tubules whatever, the cerebrum may be almost entirely wanting, there may be absence or complete stenosis of a considerable portion of the intestinal tract, without any other evidence of disturbance in fetal development. Immediately after birth, however, these essential organs which must perform their automatic function in order that life may continue, are not equal to the task and the infant perishes. Owing to the placenta, then, disease and deformity entirely incompatible with postnatal life may be present in the fetus without any material influence on its nutrition and growth.

Again, the placenta acts as a barrier to prevent the introduction of infective agents to the fetus from the maternal fluids. It is true that this barrier is, at times, penetrated, but the well-established fact that the healthy infant is bacteriologically sterile at the moment of birth is conclusive evidence that the placental barrier is effective. That it does break down not infrequently is shown by the common occurrence of infectious disease when the fetus has been inoculated through the maternal blood stream. The contrary is also true that the placenta is the sole means by which infective agents may reach the fetus, if we accept the apparently negligible potentiality of the liquor amnii.

It is also true that if the placenta be the seat of lesions or disease, it may be unable to properly supply the fetus, and thus act as an agent for serious damage to that organism. Finally, it seems probable that there is some specific placental secretion or enzyme which may exercise a profound influence upon fetal development. This latter view is as yet unsupported by experimental evidence.

To recapitulate, then, disease in the fetal period is comparable to postnatal disease with the modifying factors of fetal environment and the influence of the placental circulation.

Classification of fetal disease is a complex task, and even the most condensed grouping covers practically the whole subject of medicine. Ballantyne's plan is the one which seems to be most workable.

the virus of smallpox, entering the fetus via the umbilical canal, may cause lesions in the organ along the placental walls of invasion without affecting the skin. The eruption in intra-uterine smallpox is irregular, the pustules usually few but as in the case of Cless even the hemorrhagic form may be seen.

Measles and *scarlet fever* have also been reported in the fetus, the older literature containing many such cases.

Typhoid fever also has been shown to develop in utero. Ballantyne quotes a series of authenticated cases in which the bacillus of Eberth was found in the spleen, bone marrow, and brain of the infants and Griffith describes a case in which the infant was quite healthy except for a slight jaundice. Nevertheless, when seven weeks old its blood gave a positive Widal reaction. Griffith thought that the child may have had typhoid fever in utero and recovered after a short attack, and that the agglutinating principle may have passed through the placenta from mother to fetus without the latter having contracted the disease at all.

Fetal malaria has been known for very many years but since the discovery of the malarial plasmodia the number of reported cases has greatly increased. Attempts to discover the organisms in the fetal tissue have not been crowned with success, both Caccini and Bastianelli obtained negative results. However, the characteristic splenic enlargement and malnutrition of the infants born of malarial mothers are characteristic. Negri observed 34 cases in pregnant women of which 18 per cent terminated by spontaneous expulsion of the fetus, and Economos in 1907 found the plasmodium in 6 out of 7 newborn infants whose mothers had malaria. The administration of quinine in large doses to the mother is indicated as a prophylactic against abortion or premature labor. Other exanthematous diseases may also be transmitted but the facts are not fully understood and, indeed, the whole question is to some extent still subjudice.

Tuberculosis.—Congenital tuberculosis might be acquired in one of three ways: First, the tubercle bacilli may enter the ovum with the fertilizing spermatozoon either attached to the surface of or actually within the male germ cell. Second, the tubercle may be lodged with the ovum which is later fertilized. Third, the tubercle bacilli may have been attached to either the spermatozoon or the ovum and gain access to the latter shortly after fertilization. The question as to whether an infected fetus would develop is gravely doubtful (Norris).

Congenital tuberculosis is rare, although undoubtedly a number of authentic cases have been reported (McCord). Transplacental infection is most likely to occur in the last few weeks of pregnancy and the fetal liver and especially the lymph glands are the tissues most frequently attacked. The prognosis in such cases is usually unfavorable by reason of the virulent nature of the organisms and the vital character of the organs usually involved. The great majority of tuberculous infants undoubtedly acquire the disease as a postnatal infection, and therefore the child of a tuberculous mother should at once be removed from its parent and carefully guarded against infection from this source. For a complete review of the literature, the reader is referred to the monograph of C. C. Norris.

Fetal Sepsis.—But little is known of the transmission of sepsis from mother to fetus, but cases have been reported in which streptococci have been found in the fetuses of women suffering from septicemia. There is not sufficient

death leading to the less frequently observed early syphilitic abortions, or there may be previable or premature dead-born macerated fetuses, or living fetuses with active syphilitic disease tending soon to succumb to the infection, or full-term fetuses may be born either with or without clinical evidence of this disease at the time of their birth. The infants who survive may manifest early evidence of this disease as congenital syphilitics, or there may be a retarded development of the infection during infancy. It is recognized that a woman who has had syphilis may give birth to a healthy infant. It is also known that a woman who has shown no apparent signs of syphilis may give birth to an infected infant.

The history and clinical evidence are naturally of the greatest importance, when available, but routine blood Wassermann tests should also be done on all pregnant women. The cord Wassermann is not important except when positive, and it is usually negative. Retroplacental blood may be used for the test and it is thought by some to be of distinct value in the diagnosis.

In those fetuses born alive, the skin lesions, especially those around the orifices, and on the palms and soles, are most characteristic. Snuffles may be present, and one may demonstrate a large liver or spleen.

Where the product of conception is dead born or subsequently dies, careful examination, both gross and microscopical and by the *x*-ray, will reveal information of diagnostic and other value. The roentgen examination of the long bones of the older fetuses often shows characteristic pictures of osteochondritis syphilitica. The spirochete seems to disappear rapidly from dead tissues unless incubated. It is the one absolute evidence of the presence of this infection, though there are pathologic changes in the older fetuses and their annexa, which are almost pathognomonic.

The tissue changes which are found occur not only in the fetus itself, but also in the placenta and umbilical cord. Grossly, there is no single constant change which can be regarded as pathognomonic. It has been thought that the ratio between placental and fetal weight is about one to four in syphilitic, as compared with one to six in nonsyphilitic, fetuses. Attention should be called to the fact that while there is a definite correlation between placental and fetal weight the ratio is not constant and the placenta is relatively heavier for premature than for mature fetuses. A large percentage of syphilitic fetuses are premature, so that the alteration in the ratio is not as great as it might seem. One of us plotted a series of cases and found the placental weight to be higher for syphilitic than for nonsyphilitic fetuses of corresponding size. Some increased weight probably could occur from the fibrotic changes which take place in the placenta. The placenta is sometimes of a pale, pinkish, somewhat mottled appearance, with red and yellowish-white patches. It often has a rather greasy appearance, and, at times, seems softer and more friable.

The cord shows no characteristic gross changes, though, microscopically, one finds evidence of endarteritis and thrombosis, together with the presence of the treponema pallidum. Similar changes occur in the vessels of the placenta, and the spirochetes are found both in the maternal and fetal portions of the placenta. Fränkel's disease of the placenta is apparent when the villi are teased in salt solution; they are found to be club-shaped and to have lost their arborescent appearance. Williams found that characteristic pla-

Food.	Average serving.	Calories.
Maple syrup	2 tbsp.	200
Margarine	1 tbsp.	83
Mayonnaise	1 tbsp.	100
Milk (whole)	1 glass	150
Milk (skimmed)	1 glass	74
Molasses	1 tbsp.	71
Muffins (bran)	1	100
Muffins (wheat)	1	125
Mushrooms	4	45
Mutton (see lamb)		
Noodles (cooked)	2 tbsp.	93
Nuts—Almonds	10	65
Peanuts	⅛ cup	94
Pecans	8 halves	72
Walnuts	4 halves	125
Oatmeal	½ cup	50
Olive oil	1 tbsp.	100
Olives (green)	2	50
Olives (ripe)	3	31
Onions (creamed)	2	100
Onions (raw)	2	50
Oranges	1	75
Orange juice	½ cup	56
Oysters:		
(fried)	6	290
(raw)	6	75
Oyster stew	1 cup	200
Parsnips	½ cup	66
Peaches (canned)	½	40
Peaches (dried)	4	140
Peaches (fresh)	1	42
Peanut butter	1 tbsp.	100
Pears (canned)	½	75
Pears (fresh)	1	65
Peas (canned)	½ cup	60
Peas (fresh)	½ cup	60
Pie—Apple	1 slice	200
Butterscotch	1 slice	225
Custard	1 slice	225
Lemon	1 slice	300
Mince	1 slice	450
Peach	1 slice	300
Pumpkin	1 slice	200
Pineapple (canned)	½ cup	157
Pineapple (fresh)	⅔ cup	44
Plums (fresh)	1	17
Pork chop (medium)	1	200
Pork roast (no fat)	1 slice	200
Post Toasties	1 cup	50
Potato (baked)	1	100
Potato (boiled)	1	100
Potato (creamed)	½ cup	125
Potato (mashed)	½ cup	100
Potato, sweet	1	84
Prunes, stewed	6	300
Pudding—Blanc mange	½ cup	200
Tapioca	½ cup	100
Junket	½ cup	100
Rice	½ cup	100
Radishes	3	4

Such a chain of factors would include the development in the mother of one or another of the forms in which toxemia is manifested, and as a result of this the production of a tendency toward edema in general, the edema being most marked at the point at which blood and other body fluids interchange. This point is where the structure is most specialized, *i. e.*, the stratum spongiosum of the placenta and the tufts of the villi. There would then ensue an edema of the placenta and a decrease in its functioning capacity, with a secondary alteration in nutrition and a circulatory disturbance in the fetus, culminating in a general edema of the fetal organism (Figs. 252, 253).

Obstetrically, these cases are important because of the dystocia resulting from the enormously distended fetus, although in the majority of cases labor is spontaneous. One of the authors (Schumann) has made a detailed study of this condition with a review of the literature.

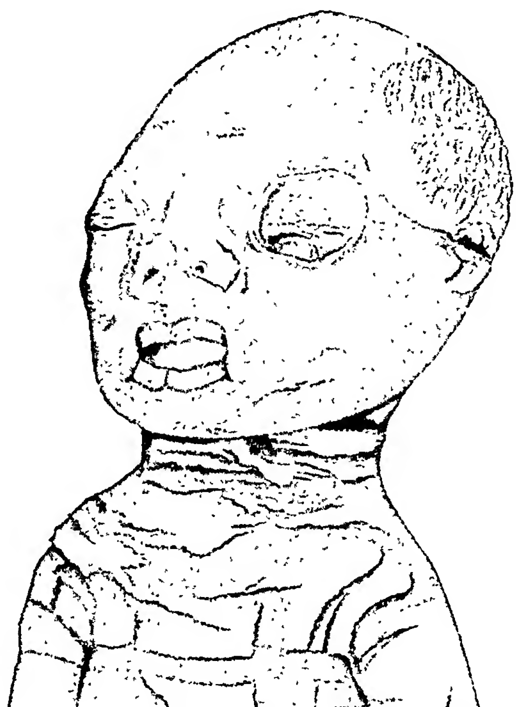

Fig. 254.—Kyber's case of fetal ichthyosis.

Fetal ichthyosis may be defined as a skin disease of the fetus, probably developed about the fourth month of intra-uterine life, characterized by the appearance over the whole surface of the body of horny epidermic plates, separated from each other by fissures and furrows and leading to the death of the infant very soon after birth. There are commonly associated deformities of the mouth, nose, eyes, ears, and extremities. The appearance of an infant with ichthyosis is highly characteristic, the general color being yellowish, the cracks and fissures of a red or bluish tint. The thickened skin plates have been compared to a coat of mail or to the bark of a tree. To the touch the epidermis is hard, leather-like and cold. The whole appearance of the infant is most repulsive and happily it usually dies almost immedi-

growths are present along the shafts of the long bones, often near the epiphyseal ends. The roentgenogram shows the cortical line contours around the tumor masses which have varying amounts of calcification.

Multiple enchondromata rarely occur but the condition seems to be different from those previously described. The x-ray shows spheroidal rarefied areas in the bones affected, usually the long bones or those of the hands or feet. These tumors increase in size and encroach upon the soft parts, and are not covered by the cortical line. There is a congenital condition known as *arthrogryposis multiplex congenita,* which is rare and is characterized by congenital limitation of motion in all the joints except those of the spine and maxillae. The etiology is obscure but the joint surfaces, muscles, and tendons show no evidence of abnormality. The joint capsules seem to be thickened. It has been suggested that there may have been an intra-uterine periarthritis.

Fig. 255.—Chondrodystrophia fetalis. (Hirst, "Text-Book of Obstetrics.")

This is not an osseous disease but may be mentioned in a consideration of skeletal disorders.

Mongolism is a disorder affecting the whole organism. The most characteristic external appearance is a mongolian-like facies. The etiology is not known. There are some skeletal changes which cause no obstetrical complications. The skull is bradycephalic and there is a flattened occiput, the cheek bones are not prominent, there is some separation of the sutures and the sella turcica is flattened. There is a diminished skeletal length. The hands and feet are broad and short with shortened phalanges, especially the second series. Fortunately these infants do not develop into sexually mature individuals.

Cretins rarely show characteristic changes at the time of birth. This condition occurs both sporadically and endemically and is due to aplasia and hypoplasia of the thyroid gland. Prenatal care of the mother and the use

1. Malformations due to arrest of development, as hypoplasia of the whole body, aplasia of single organs or of parts of the body. Arrest of development in the form of fissure or duplicature, fissure in the median line of the thorax or abdomen, fissure in the face, doubling of the vagina and uterus, fusion or union of organs lying in relation to one another.

2. Malformations due to excess of development. Partial or general excess of growth, increase in the number of organs, mammary glands, spleen, suprarenal capsules, fingers and toes, teeth, ribs, and vertebrae.

3. Malformations due to errors in development (monsters by altered relation). Transposition of viscera, ectopia testis, etc.

4. Malformations due to displacement of tissue and persistence of fetal structures; dermoid cysts, etc.

5. Malformations due to the fusion of sexual characters; hermaphroditism.

(*b*) Double monsters.

The question of greatest interest in a study of monsters is the cause of their abnormal development and the manner of its action. The ultimate cause is now considered to be concerned with one of two entirely independent factors; either it is some alteration of the germ plasm itself, by which the monster is begun at the moment of conception or very shortly after, or there occurs some error of implantation of the ovum causing improper development. The germ plasm theory was strongly held by the older teratologists, but has since been largely supplanted by the principle of faulty implantation of the ovum, except in the case of certain hereditary forms and in cases of double monsters, wherein it still holds good.

Schwalbe, in discussing the probable cause of double monsters, reaches the following conclusions:

1. In the cases of most double monsters the time for the action of the cause closes with gastrulation.

2. The primary cause is a subdivision of the egg material which develops two formative centers.

3. The cause may lie in a displacement of the early blastomeres with respect to the norm (granting with Driesch that the prospective significance of a cell is a function of its position, a disturbance of the normal position, and hence the relationships of a cell may cause it to develop differently).

4. All that may be postulated in general, to cover all cases, is a division of the egg material. Special cases must be considered by themselves. It will be seen that Schwalbe entirely ignores the theory of faulty implantation and also that he, in common with other investigators, gives no explanation of the constant grouping of monsters, both single and double, into certain definite varieties which is so characteristic of these malformations.

With respect to merosomatous monsters the work of Mall is by far the most conclusive and searching. Working with pathologic human embryos, Mall reached the conclusion that monsters are produced by external influence upon normal ova which affect the nutrition of the embryos due to faulty implantation of the ovum. That the power to become a monster is present in every ovum is fully demonstrated by experiment upon a variety of vertebrates as well as by pathologic human ova, especially those obtained from tubal pregnancies.

This very important generalization runs directly parallel with that of Hertwig, who, after an elaborate experimental work upon the production of

Local Defects and Anomalies of Development.—Most of these conditions are not of very great obstetrical importance. They may affect any portion of the body and are easily detected either by physical examination or by roentgenography.

Agenesia or congenital absence of parts is not uncommon and may involve any bone in the body, though some portions are more frequently affected than others. Congenital absence of the radius occurs most frequently, and congenital aplasia of the femur or tibia is relatively frequent. This condition is not infrequently found in the cranial vault and vertebral arches. Osseous defects are usually associated with other deformities. Localized hypoplasia and hyperplasia are not at all infrequent.

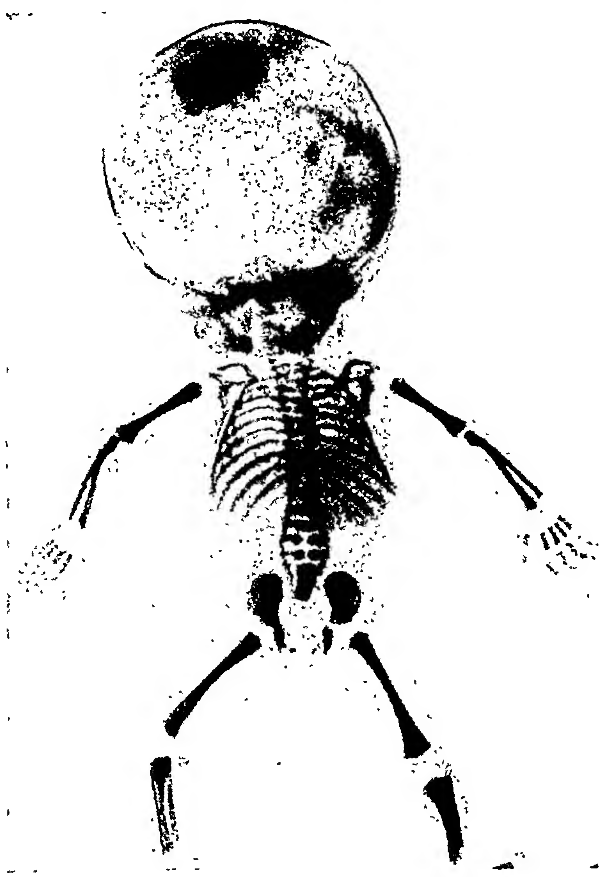

Fig. 256.—Radiogram of an hydrocephalus. (Birnbaum and Blacker.)

The *skull changes* are frequent and often marked and are of special interest as they may complicate the diagnosis and prognosis of labor. The head may be altered in size or shape and may be associated with changes in the cranial contents. The bones themselves vary in size, shape, and density and there may be defects leading to clefts on the ventral or dorsal aspects with such conditions as cleft palate, meningocele and encephalocele.

Hydrocephalus often presents a serious complication but occurs only about once in 1500 cases. It is not infrequently associated with spina bifida and hydramnion. The diagnosis during pregnancy has been greatly facilitated by the advent of x-ray pictures. The experimental work of Dandy

conditions in which the skeletal structures are involved give valuable and definite information. Malformations of the phalanges are common. A deficiency in number is called *oligodactylia,* an increase in number is termed *polydactylia,* and a fusion of the digits is known as *syndactylia.*

Defects Associated with Major Malformations, Monsters, and Fused Multiple Pregnancies.—Some of these conditions have already been considered in connection with the deformities of the skull and spine.

The occurrence of teratomata, parasitic twins, monsters with multiple extremities and fused twins are not uncommon; there are numerous cases in the literature. They are difficult or impossible to diagnose prior to birth except by the use of the *x*-ray. The recognition subsequent to birth should generally be easy.

We know little of the etiology of these conditions and nothing regarding the prophylaxis. Very few of these individuals live, though there are some notable examples of survival of conjoined twins. They are single ovum twins, always of the same sex and the suffix *pagus* is used to indicate the fusion. A prefix indicating the part fused is attached, as in *thoraco*-pagus.

Mall in his chapter on "The Pathology of the Human Ovum" states that "from comparative embryology we have learned that in normal development the tissues are transparent and sharply defined and that the organs of the embryo and its membranes maintain constant proportions in each stage of development. Any marked variations from these constants, which as yet are not well established, are to be viewed as anomalies, but if they are accompanied by distinctive tissue change of a pathologic nature, we view the ovum containing them as diseased or pathologic. When the pathologic processes of the ovum are pronounced the villi are atrophied and irregular; the chorion is thin and transparent or thick and hemorrhagic; the embryo is usually dwarfed in an irregular fashion; the exocoelom is often filled with an excessive amount of dense reticular magma; and there is usually hydramnion with a granular deposit in the liquor amnii. These are the chief changes which are easily seen by a superficial observation of a pathologic ovum, and since all of the changes are relative their recognition depends absolutely upon a knowledge of the normal form and relation of the structures within the ovum."

Granville many years ago studied 45 aborted ova and concluded that the chorion was primarily diseased and believed that there was an antecedent inflammatory condition.

Various causes have been assigned for unintentional abortions, such as physical and psychic stress, malposition of the uterus, inflammation of the endometrium, faulty implantation, etc., but very little emphasis has been placed upon disease of the ovum and embryo itself.

Mall concludes that about 38 per cent of all his embryos are abnormal, and that if they are divided into groups, about 70 per cent of those pregnancies ending in the first five and a half to six weeks are pathologic, whereas from this period up to nine weeks the percentage is only about 36.

Mall uses Marchand's figures relative to monsters (615 in 81,187 births) and, from Williams' statement that about 20 per cent of pregnancies end in abortions, concludes that from each 100,000 pregnancies 80,572 births, 11,765 abortions of normal embryos, 7048 abortions of pathologic ova, and 615 monsters would result. Reduced to percentages the figures would be about 80, 7, and 0.6 per cent, respectively. It is difficult to know the actual

types known as *craniopagus* and *ischiopagus*. The trunks may be united giving rise to the varieties of monsters known as *thoracopagus* and *dicephalus*.

In some cases the fetal body has ventral clefts, more commonly of the abdomen, though the thorax or pelvis may be the site of such malformations. The abdominal defect may reveal itself as an ordinary umbilical hernia; there may occur a more extensive abdominal hernia or a complete eventration may exist. In addition to these affections there may be generalized or local enlargements which may cause complications of labor. One can enumerate such conditions as hydrops fetalis universalis and elephantiasis congenita custica. Destruction of body cavities with fluid may occur as a hydrothorax or hydroperitoneum with or without peritonitis. An enormously distended bladder may rarely be found as a cause of dystocia. Congenital cystic kidneys have been described as well as tumors of the liver, testicle, etc. All of these conditions are unusual and a fairly large obstetrical practice may not bring any of these fetal abnormalities under observation during a lifetime. These variations from the normal have little relationship to the physiology and anatomy of the fetus.

The remaining groups of fetal disease are largely explained by their names, and to discuss them in detail would lead to a review of practically the whole subject of clinical medicine. They are mentioned simply as an illustration of the enormous field covered by fetal pathology.

The injuries and accidents of birth and the irregularities of beginning function in those organs, latent during intra-uterine existence but essential to life immediately upon the cessation of placental circulation, constitutes the pathology of the intranatal and neonatal period. It has been well said that "birth is the traumatic transition from an intra-uterine to an extra-uterine existence."

The next phase for discussion is the intranatal, or intrapartum, period.

The factors which operate to produce abnormal conditions in the fetus during parturition are trauma, suffocation, aspiration, infection, and possibly metabolic disturbance. These affections are more or less interrelated and often they are combined as the causes of fetal disease and death.

In the rather recent past, most intranatal fetal deaths were attributed to disturbances of oxygenation, and asphyxia neonatorum was accepted as an entity of which two main types were recognized, namely, the livida and the pallida.

The establishment of respiration is the most important physiologic phenomenon marking the transition from fetal to neonatal life, and it marks in reality the beginning of extra-uterine life. The fetus is apneic in utero and it is born in that state. We know that the fetus can make respiratory movements before birth, but whether it does so, except in response to some unusual stimulus, we do not know. There is probably some marked change of a chemical character, which renders the respiratory center more susceptible to stimuli at the moment of birth.

There are many reasons why the gaseous interchange may be interfered with during labor, and then some stimulus to the brain, or medulla, may start respiratory movements prematurely. These movements would be of no avail, as there could be no pulmonary ventilation, but there might be aspiration of fluid. Such aspirated material, even if located only in the upper respiratory tract, could, if birth followed soon afterward, be drawn into the

difficulty, or not at all, are traumatized and in shock, and should be handled accordingly, and not treated by vigorous methods for the purpose of establishing respiration.

The simplest form of head injury is the so-called "caput succedaneum," which is a bloody edema of the scalp and underlying tissues. On cut section one finds the edematous tissue with many ecchymoses, and after the edema has disappeared the area has every appearance of a more or less severe contusion. This results from unequal and prolonged pressure on the scalp and head. It gives one a clue to what may be taking place within the cranium. The scalp may be lacerated or may undergo necrosis from prolonged pressure in the birth canal or from instrumentation.

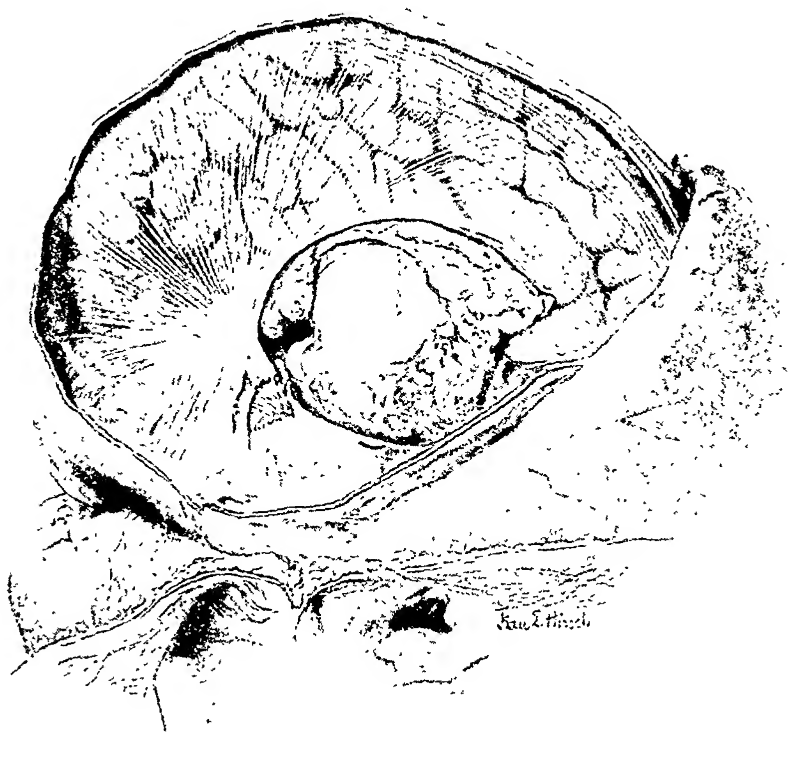

Fig. 259.—Birth trauma. Intracranial damage. Laceration of right tentorium resulting from version and extraction.

When vessels rupture and there is hemorrhage with an accumulation of blood between the osteogenetic membrane and the bone, a cephalhematoma is formed. All obstetricians are familiar with this hematoma on the child's head, over a circumscribed area of one or more of the skull bones. It is not so commonly known that a less frequent, but more serious, condition can arise within the skull and produce considerable pressure upon the brain. These hematomata are known as cephalhematoma externa and interna, respectively; they are simply extravasations of blood limited to individual skull bones by the firm attachment of the osteogenic membrane at the margin of the bone.

The bones of the skull may be fractured, usually during artificial delivery.

tant points in the anatomy of the skull are brought out clearly by this author. The dura mater consists of an outer layer, made up of the osteogenic membrane, lining the inner surfaces of the cranial bones, and an inner, or serous, layer, which covers the surfaces of the dural folds, which lie in apposition with the brain envelope.

The outer layer is channelled by the various venous sinuses and sends four septa into the cranial cavity: (1) the falx cerebri, (2) right and (3) left half of the tentorium cerebelli, and (4) the falx cerebelli. These septa meet at a common point opposite the torcular Herophili. The membrane is especially strong around the sinuses, and is firmly adherent to the bone opposite them. The falx cerebri and tentorium meet and blend into a line termed the white line, which lies beneath the straight sinus and occupies the angle where the two halves of the tentorium meet. This white line follows along the straight sinus, to end in a firm mass of fibrous tissue attached to the occipital bone, near the torcular Herophili. The dural septa are traversed by bands of a firmer and stronger character, termed "stress bands," which may have a special protective function in limiting the movement of the cranial bones. These bands are divided into an anteroposterior and a vertical system. The anteroposterior system is arranged around the torcular Herophili and is irregular and complicated by the channels of the torcular, superior, longitudinal, straight and occipital sinuses, which are closely arranged around this system of fibers.

The vertical system consists of two opposing sets of convergent fibers, one from the falx cerebri above and one from the tentorium below. The former originate from the middle two thirds of the falx; the latter arise, chiefly, from that part of the tentorium which covers the lateral sinus. Alterations in the shape of the head are divided into two groups: (1) decrease in the anteroposterior measurement, and (2) increase in the anteroposterior measurement as are seen in the vertex and face presentations, respectively. As the result of head compression and molding, these bands are subject to stress, which is often sufficient to produce lacerations. The tentorium is frequently torn in a triangular area located below the line of junction of the tentorium and falx, and posterior to the anterior vertical band. The tears may be unilateral or bilateral, and complete, through both tentorial layers, or incomplete. They are often associated with tears of the falx cerebri. Hemorrhage is not always associated with such tears and it varies greatly in amount, from a few drops to extensive basal hemorrhage. The hemorrhage may come from ruptured capillaries and, in some cases, it may arise from ruptured sinuses or veins, principally the vein of Galen and its tributaries, which are located near the apex of the tentorium. This is the point of maximum stress in head molding, resulting from anteroposterior compression. Its tributaries are two basal veins, some from the superior cerebellar surface, some from the midbrain, and the pons. There are also some cerebellar veins which enter the straight sinus directly.

Holland is of the opinion that the usual source of hemorrhage is from the tributary vessels of the cerebellum and midbrain and from the other cerebellar veins which enter the straight sinus. They rupture as the result of engorgement, plus stretching.

A few additional points which merit attention:

First, it should be emphasized that tearing of the dural septa per se is

Fetal disease is often associated with pain or discomfort on the part of the mother, and investigation of such condition should be made with a view to the possible diagnosis of the cause of the symptoms, not only with reference to the mother, but also to the child.

The diagnosis of antenatal disease is still almost virgin ground, the more so because of the dearth of detailed observations of the pregnant woman who eventually gives birth to a diseased infant. Certain physical signs have been oriented, however, and form a nucleus which may develop into a considerable group of diagnostic facts.

Hydramnion, for example, may be diagnosticated, and is known to be very frequently associated with monsters or with twins. It is known that weak, irregular and arrhythmic fetal heart sounds may be present in the case of anencephalic or other monsters in which the cerebral and spinal centers are so ill developed that this regulating action of the heart muscle is lost.

The fetal size and state of nutrition may be estimated, the vigor and character of the fetal movements have been found to hold a certain significance and, in fact, the physical signs leading to a diagnosis of fetal disease, if marshaled in order, already form a respectable group, and with a quickening interest in antenatal diagnosis, must grow to become an important factor in obstetrical work.

Lastly, there is the matter of antenatal therapeutics, and here, unfortunately, there is but little to be said. General hygiene of the mother, to produce a well-nourished infant, protection from trauma and infections, a guarding against ovular infection by physical examination of the man contemplating matrimony, are preventive measures long practiced and found efficacious.

Salvarsan and mercury in the case of the pregnant syphilitic woman, calcium salts and blood serum in the gravida with a history of hemophilia, and such general therapeutic schemes make up the sum of our knowledge.

The future offers hope, however, and it seems beyond question true that more careful study of the pregnant woman from the standpoint of the child, her treatment and observation, not only as an out-patient, but in hospitals, whenever there is any reason to suspect any fetal difficulty, and a collection of detailed data upon the course of all pregnancies which differ in any way from the normal, and their results as regards the infant, will enable us to shortly have many more facts at our command; and that by the application of our knowledge of the results of abnormal pregnancies to the causes of fetal disease the whole subject of antenatal pathology will attain a workable scientific basis, giving to medicine another unit of power for the betterment of our race and species.

The Causes of Fetal Death

Analysis of a large series of stillborn infants discloses the disheartening fact that the great majority are due to accidents of labor, and therefore largely preventable, or to maternal diseases during pregnancy, also in large measure avoidable before delivery.

The very comprehensive report by Eardley Holland and Janet Lane-Claypon discloses this fact very clearly. Their summation of the causes of fetal death in a large and closely studied series is as follows:

DEVELOPMENT OF THE PRONEPHROS, MESONEPHROS, WOLFFIAN, AND MÜLLERIAN DUCTS

Formation of the Intermediate Cell Mass.—Since the urinary and generative organs are developed from the intermediate cell mass which is situated between the primitive segments and the lateral plates (somatic and splanchnic) of mesoderm, the period of its formation is the logical point of departure in our presentation. With the exception of the lower portion of the vagina, and a portion of the bladder and urethra, both the excretory and reproductive systems are mesodermal in origin. The mesoderm forms a wedge-shaped plate on each side of the medullary tube and the notochord, the base of the wedge being its medial surface, which is directed toward the medullary tube, its edge being the lateral border (Fig. 260, *a*). The dorsal portions of the wedge are divided by transverse grooves into a series of successive and equal portions, each division termed a "primary primitive segment" or "somite." Each primary primitive segment of the mesodermal plate differentiates into three portions, the secondary primitive segment, the primitive segment stalk (intermediate cell mass), and the lateral plate, which later divides to form the somatic and splanchnic mesoderm between which the coelom or body cavity is developed (Fig. 260, *b* and *c*). The intermediate cell masses furnish the tissue from which the tubules of the pronephros, mesonephros, and metanephros are developed. It follows from this that the excretory and genital systems cannot be a unit, but must be composed of as many parts as there are intermediate cell masses entering into its formation. From the figures it is obvious that the tubules are formed outside the coelom. They are, therefore, from the very beginning *retroperitoneal.*

With the progress of development, the secondary primitive segments and the intermediate cell masses become separated, the opening in the wall of each at the point of separation closing at the same time (Fig. 260, *b* and *c*).

Pronephros and Wolffian Duct.—The human pronephros is a vestigial structure, but being the first part of the urogenital system to be differentiated in the vertebrate embryo, it must be regarded phylogenetically as the oldest part. Though some authors (Tandler, 1905) have claimed that the hydatid of Morgagni in the adult female is the remains of the pronephros, Felix (1912) has shown that this cannot be so, and that it is the vestige of the degenerated cranial portion of the mesonephros.

The pronephros in man does not function as an excretory organ and its period of development as a consequence is very short. The first sign of the pronephros consists in the development of pronephric tubules. In the upper cervical and lower thoracic segments the parietal layer of each intermediate cell mass forms an evagination directed toward the ectoderm. This is termed the *principal tubule* (Fig. 260, *c*). The full end of each principal tubule bends and grows caudally beneath the ectoderm, reaches the next succeeding one, and fuses with it. By the fusion of all the principal tubules a *collecting duct* is formed which is situated just under the ectoderm and overlying the pronephros. The collecting duct grows caudally to reach the lateral and ventral portions of the cloaca when the embryo reaches the size of 4.25 mm., and forms the *wolffian duct.** The perforation of the cloaca is said to occur in embryos

* Among embryologists the crown-rump length of the embryo is used as a standard in the indication of the embryological development. It will be employed for this purpose throughout this chapter, without further explanation.

canal between the principal tubule and the lateral plates; this is termed by Felix the *supplemental tubule,* which opens into the coelom. In Fig. 260, *d,* the principal and supplemental tubules have elongated; and the latter by the

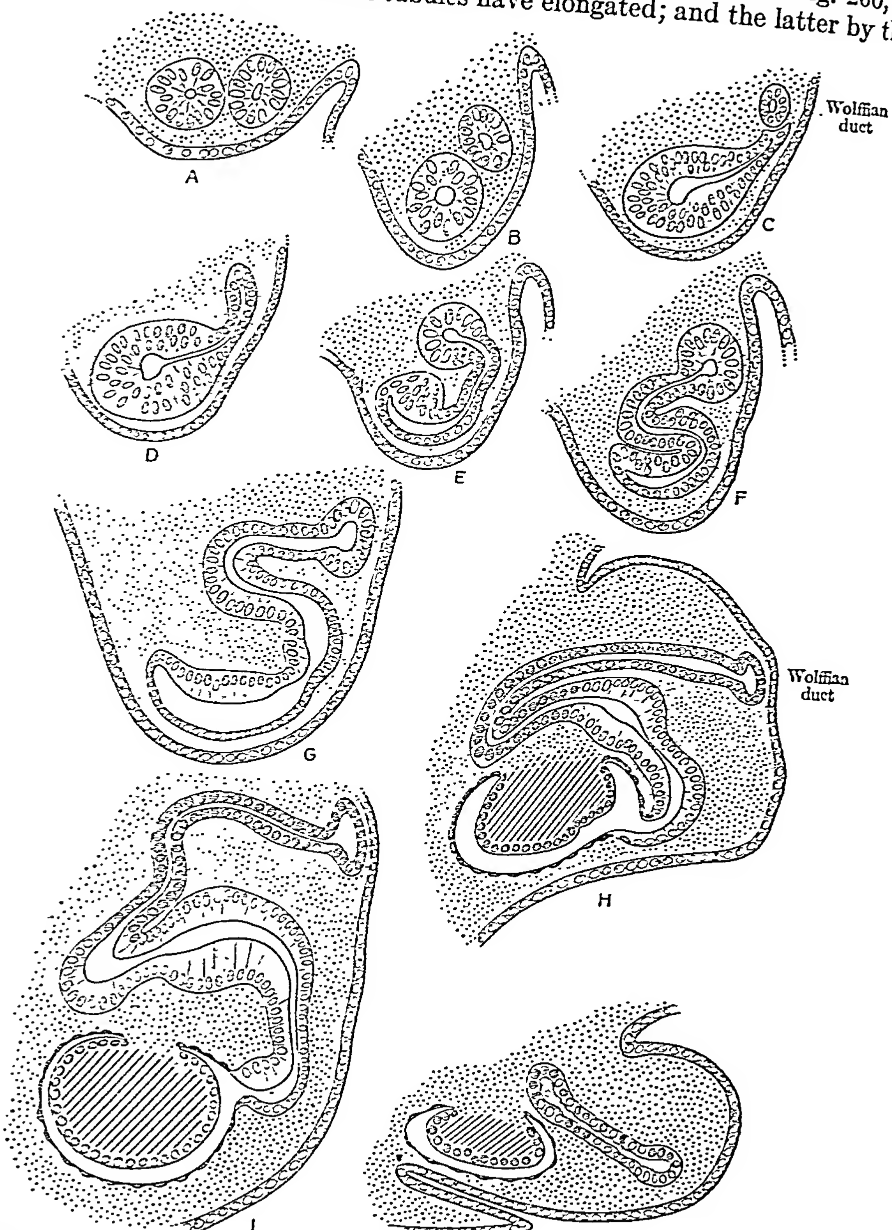

Fig. 261.—Diagram illustrating the development of the S-shaped mesonephric tubule. (J. Shikinami, Contributions to Embryology, vol. 18.)

widening of the portion immediately adjacent to the principal tubule has become divided into two parts, a broad medial one invaginated by the vascular glomerulus, and a narrow lateral one which is connected with the lateral

(proximal to the wolffian duct) is formed the collecting tubule. This process is well illustrated in Fig. 261, A–J. The cells covering the glomerulus are cuboidal in shape and have spherical nuclei, while the outer lamella of the glomerular capsule is composed of pavement epithelium containing oval nuclei. The cells composing the wall of the secretory portion of the tubule are of high columnar type with nuclei in the basal portions. The collecting

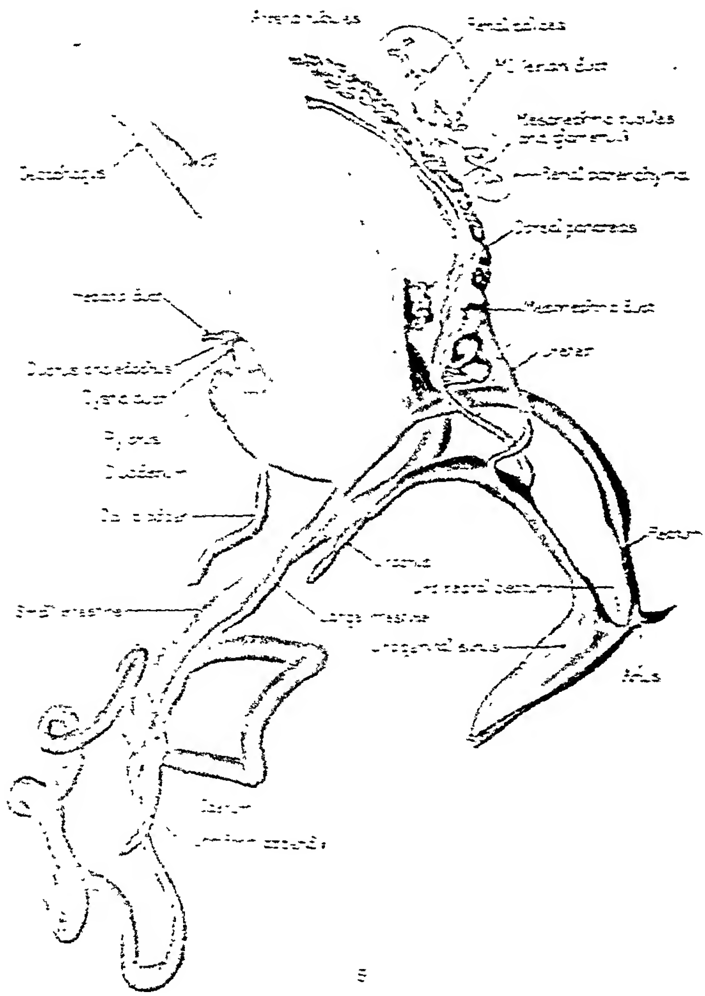

Fig. 263.—Model of a 23-mm. embryo showing degeneration of the very cranial portion of the mesonephros. The müllerian is lateral to the wolffian duct. (J. Shikinami, Contributions to Embryology, vol. 18.)

tubule is lined with low cuboidal cells containing spherical nuclei. The tubules and glomeruli collectively constitute the mesonephros or wolffian body, which reaches its maximum development at 9.5 mm. (Shikinami, 1926, and Felix, 1912).

Figure 262 is a wax plate reconstruction showing the structural details of the mesonephros (wolffian body) of a 5.5-mm. human embryo. There are

The Urogenital Fold.—The mesonephros is formed along the posterior wall of the coelom, the future peritoneal cavity. It is situated retroperitoneally, and as it grows larger the peritoneum is pushed forward as a fold into the coelom. This fold later contains the müllerian duct and the genital gland, in addition to the mesonephros and the wolffian duct. It is therefore termed the "urogenital fold." The development of the latter, and its importance, is shown by the following figures, taken from Felix's section in Keibel and Mall's Human Embryology (Fig. 264, *a*, *b*, *c*, *d*, *e*).

The posterior coelomic epithelium throughout its entire length is pushed forward by the developing mesonephros and thus forms the early urogenital fold (Fig. 264, *a*). As shown in Fig. 264, *b*, the fold increases in size by the

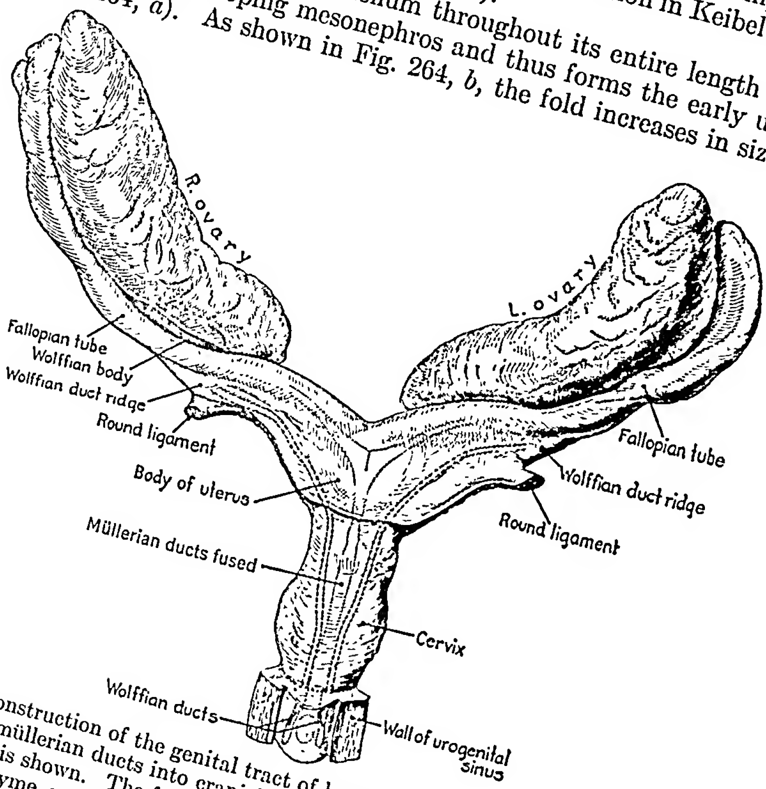

Fig. 265.—Reconstruction of the genital tract of human embryo 48 mm. C. R. length. The division of the müllerian ducts into cranial vertical, intermediate transverse and caudal vertical portions is shown. The fused caudal vertical portions, the wolffian ducts and surrounding mesenchyme constitute the genital cord. (R. H. Hunter, Contributions to Embryology, vol. 22.)

entrance of the posterior cardinal vein, and soon undergoes a series of important changes. In the first place, it becomes divided throughout its whole length (from cervical to fourth lumbar segment), with the exception of its very cranial and very caudal ends, into a genital and mesonephric fold (Fig. 264, *c*, *d*). The genital gland develops from the coelomic epithelium anterior to the mesonephros and medial to the wolffian duct. Once formed it becomes surrounded by deep grooves laterally and medially, separating itself by a stalk or mesentery from the rest of the fold. This, at full development, forms the mesovarium. During this division the urogenital fold itself becomes still more cut off from the posterior body wall laterally and medially so that it, too, develops a mesentery which eventually takes part in the formation of the broad ligament.

in section c the mesonephric folds have fused, the müllerian ducts on each side approximating each other, having undergone a ventral rotation of 90 degrees. Because of this rotation of the müllerian portion of the urogenital folds from a lateral to a median position and their subsequent fusion to form the genital cord, the ovary in its descent must necessarily occupy a position posterior or dorsal to the pelvic partition, since it was medial to the mesonephric fold originally.

Another important change in the urogenital fold is the formation of a promontory-like growth (at 13 mm.) from the first bend of the transverse portion of the urogenital fold. This is the *inguinal fold*, which later grows to the anterolateral abdominal wall and unites with a similar projection from the latter to form the round ligament in the female, and the gubernaculum in the male (Fig. 266).

The Wolffian Ducts.—As previously stated, the wolffian duct first appears at about a 1.5-mm. stage (Myer, 1907; Felix, 1912) as a fusion of the pronephric collecting tubules by caudal growth. At a 2.5-mm. stage the tubules of the mesonephros begin to form caudal to the pronephros, and, in the same manner as above, the wolffian duct is extended caudally by the growth of some 83 pairs of mesonephric tubules. The wolffian ducts continue to grow caudally as paired tubes, and at approximately 4 mm. reach and open into the ventrolateral walls of the cloaca by separate openings. In the female the wolffian ducts keep pace with the development of the müllerian ducts until about 55 mm., when the openings into the urogenital sinus become closed. Degeneration then takes place in a cranial direction, the cranial portion remaining in a greater or lesser degree to form Gärtner's duct. Some authors claim that the lower portions of the wolffian ducts take part in the formation of the vagina, but there is no conclusive evidence for this statement. Occasionally the ducts do persist in their entirety, always ending caudally in the lower portion of the vagina. At times remnants of the wolffian ducts in the lateral wall of the vagina may give rise to fairly large vaginal cysts. Figure 267, *a* and *b*. and Figs. 272 and 273 show the course, development and degeneration of the wolffian ducts in the human female in relation to the müllerian ducts. At 25 mm. (Fig. 267, *a*) the wolffian ducts lie medial to the müllerian in the cranial vertical portions but lateral in the caudal vertical portion since the latter cross the former at the lower border of the mesonephros. In Fig. 267, *b*, the wolffian ducts have lost their openings into the posterior wall of the urogenital sinus, and proceeding cranially lie close to the fused müllerian ducts; in the cervical region they bend laterally to enter the broad ligament where they usually persist as Gärtner's ducts.

In the male the wolffian duct persists and forms the ductus deferens and the ejaculatory duct. Its cranial portion unites with that cranial half of the mesonephros which has not already undergone degeneration and forms the efferent ducts of the testis. The caudal portion of the mesonephros persists as the ductuli aberrantes paradidymis, which are sometimes found in front of the spermatic cord above the head of the epididymis. In the female the degenerated caudal portion of the mesonephros forms the paroophoron (Fig. 287).

The Müllerian Ducts.—The *müllerian duct* appears at an 11-mm. stage as an elongated invagination of the coelomic epithelium into the urogenital fold, situated lateral to but distinctly separate from the cranial extremity of the wolffian duct. This in the adult remains to form the ostium abdominale

The müllerian system can be divided into three portions, viz., (*a*) cranial vertical—parallel to the entire length of the mesonephros and lateral to the wolffian ducts; (*b*) intermediate transverse—at the level of the caudal end of the mesonephros, the round ligament and anterior to the wolffian ducts;

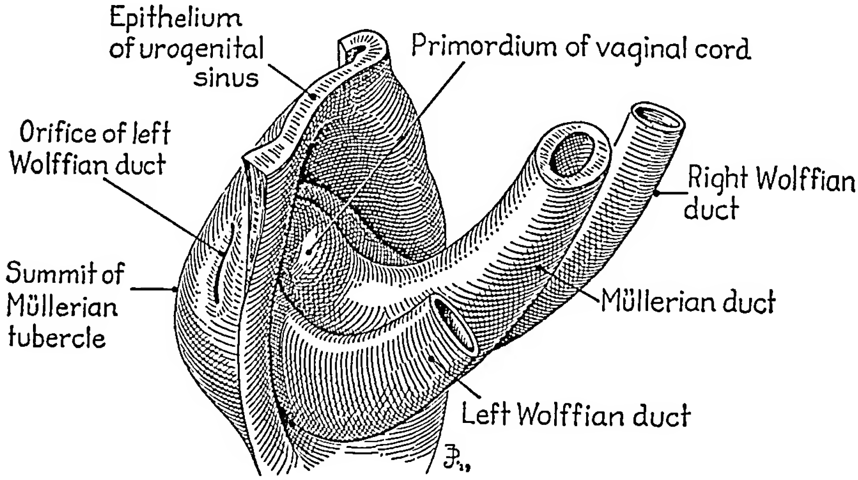

Fig. 268.—A wax plate reconstruction of the müllerian tubercle of a 48-mm. embryo. (R. H. Hunter, Contributions to Embryology, vol. 22.)

(*c*) caudal vertical—well within the pelvis and medial to the wolffian ducts. The cranial vertical portion forms the fallopian tubes, the transverse and caudal portions form, with the surrounding mesoderm, the uterus, cervix, and upper two thirds of the vagina (Fig. 265).

DEVELOPMENT OF THE FALLOPIAN TUBES

It has already been stated that the first sign of the ostium abdominale is noticed in 11-mm. embryos, at the level of the third thoracic segment, as a longitudinal shallow invagination of the coelomic epithelium on the lateral surface of the urogenital fold. The most caudal lips of the groove fuse to form a tube; thus, except for the open funnel-shaped cranial extremity it separates itself from the coelomic epithelium and the cranial portion of the müllerian duct is completed. In addition to the principal funnel from two to five accessory funnels may be formed in the same manner, but their free ends usually unite with the principal one and may persist as accessory ostia. However, the accessory ostia usually disappear. According to Felix (1912) the fimbriae arise from the irregular lips of the early invaginated area, and become distinct in embryos of 28 to 30 mm. At 60 mm. the *fimbria ovarica* appears as a grooved projection directed caudally toward the cranial pole of the ovary.

At the close of development the ostium abdominale is opposite the fourth lumbar segment, having wandered from the third thoracic. This is regarded as a true descensus, probably due to a number of factors: (1) The upper position of the duct lags behind in total growth; (2) the ostium is attached to the crux of the diaphragm and descends with it; (3) the cranial portion of the urogenital fold becomes thin, long, and loose, due to the degeneration of

between two folds of peritoneum, and fixed at either end by ovarian and infundibulopelvic ligaments, the tubes form a series of coils.

In 50-mm. embryos the loose mesenchyme surrounding the cranial vertical portions of the tube arranges itself in concentric layers around the epithelium. At 80 mm. it separates into two layers, an inner one composed of round cells, and an outer one which is much thicker and composed of spindle-shaped cells arranged in regular layers. Thus the submucosa and muscularis become differentiated. At 180 mm. the muscle fibers appear first as a circular layer; later an outer and inner longitudinal layer is formed.

The epithelium of the tube is from the beginning cylindrical and single layered. *At 50 mm. two ventral and dorsal folds project into the lumen giving* the lumen the form of a Maltese cross. These folds have a core or stroma of mesenchyme. In embryos of 80 to 250 mm. secondary folds appear, to give the tube its ultimate adult form.

DEVELOPMENT OF THE UTERUS

The uterus is formed from both the upper portion of the caudal vertical and intermediate transverse segments of the müllerian ducts (Fig. 265). The union of the paired caudal vertical portion results in the formation of a single tube, the uterovaginal canal, and the upper portion of this forms the body of the uterus. The union begins at a 23-mm. stage (Koff, 1933) and becomes complete at 48 mm. The transverse or horizontal portions of the tubes connect the cranial vertical segment with the uterovaginal canal. At the transition of the caudal vertical with the intermediate transverse portion the ligamentum rotundum arises from the mesonephric fold (Fig. 265). This intermediate transverse portion plays an important part in the development of the fundus.

At 48 mm. (Fig. 265) the condensation of mesenchyme surrounding the uterovaginal canal and wolffian ducts forms the short hourglass-shaped genital cord. The constriction between the two bulbs of the hourglass separates the body of the uterus from the cervix. The upper limit of the organ is V shaped, formed by the coming together of the horizontal or transverse portions of the paired müllerian ducts. The round ligaments are attached to the lateral limits of the horizontal portions. As development proceeds the uterine wall increases in thickness, and the mesenchyme condenses around the epithelium of the cranial portion of the uterovaginal canal. There are three distinct zones, viz., (1) an outer layer of cells which represents the subserous layer; (2) a middle layer of cells which represents the muscular wall; (3) an inner layer which represents the future endometrium. Between the outer and middle layers grow branches from the blood vessels of the broad ligaments. The muscle fibers do not differentiate until 120 to 140 mm. (Felix, 1912). This change begins in the periphery of the middle layer and rapidly involves the whole thickness of the uterine wall, as first noted by Clark (1911). However, in fetuses of 210 mm., the differentiation of the muscle layer is almost complete (Roesger, 1894).

The development of the fundus is shown by comparing Figs. 265 and 269. In Fig. 265, the fundus is V shaped (uterus arcuatus) and the ligamenta rotunda are at some distance from the uterus. As development proceeds the angulation becomes less acute and the horizontal portions of the tubes broaden in such a way as to straighten out the inward bend and increase

portion of the uterovaginal canal becomes stratified, while the caudal portions of the wolffian ducts usually lose their connections with the urogenital sinus and disappear or migrate with the sinovaginal bulbs. It is noteworthy that the tips of the wolffian ducts migrate cranially (Fig. 272), which would be expected if the urogenital sinus takes part in the formation of the lower end of the vagina. When the wolffian ducts do persist, they never end in the urogenital sinus but in the solid sinovaginal bulbs a short distance cranial to the contact of the latter with the sinus.

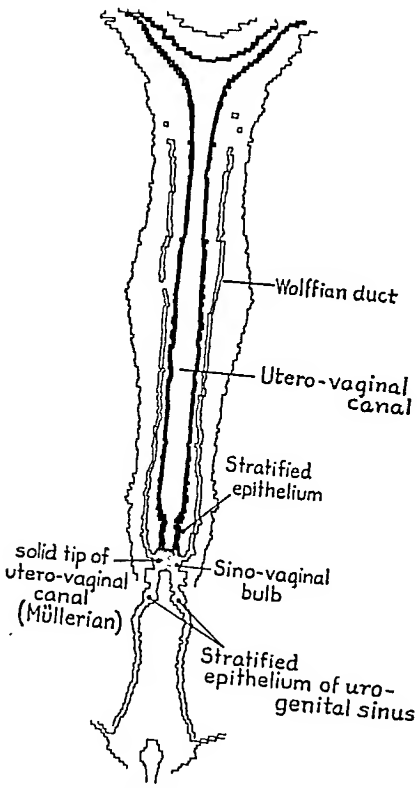

Fig. 272.—This is a coronal view of the genital cord and urogenital sinus magnified twenty times normal size and plotted on millimeter paper. The wolffian ducts are undergoing involution; their caudal tips have migrated cranially due to the growth of the sinovaginal bulbs. The latter have fused with the solid tip of the uterovaginal canal to form the solid primordium of the vagina. Note the stratification of epithelium of both urogenital sinus and fused müllerian ducts, an activity lacking in the wolffian system. (Koff in Carnegie Institution of Washington, Department of Embryology, vol. 23.)

3. **Formation of the Primitive Vaginal Plate.**—In the stage from 65 to 140 mm. the caudal portion of the uterovaginal canal becomes converted into a ribbon-like solid plate by two processes: (1) Stratification and fusion of the original cells lining the lumen, and (2) lateral outgrowth from the same epithelium. The sinus bulbs enlarge by the same process and their small cavities gradually become occluded. The epithelia of the two vaginal primordia which are easily distinguishable from each other fuse to form a solid cord, the primitive vaginal plate (Figs. 273, 274). At 120 mm. the cranial extremity of the

vagina forms a large knob or plunger which invaginates the posterior wall of the urogenital sinus to form the hymen. The epithelial excrescences from the primitive vaginal plate fuse with one another to form a thick solid vaginal cord.

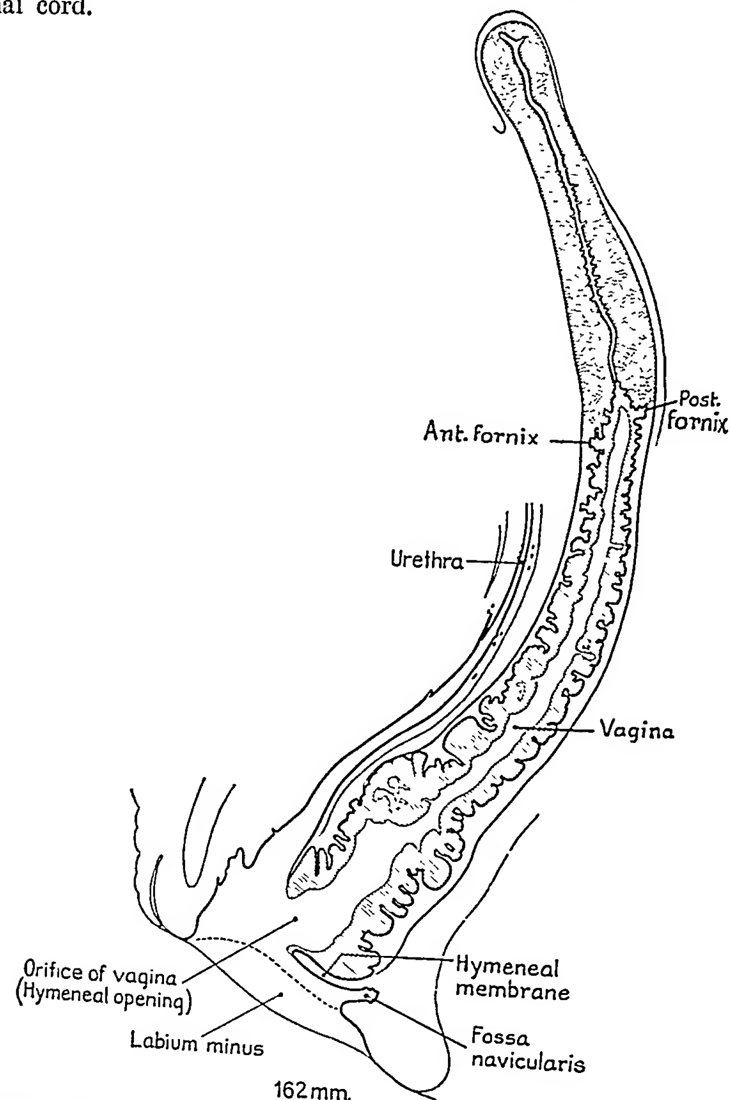

Fig. 275.—The primitive vaginal plate has become completely hollowed out except for the cranial extremity to form the definitive vagina. The vaginal lumen communicates with the urogenital sinus through the hymenal opening from where the degenerated epithelium is discharged. The posterior segment of the hymen is a disk lined internally by vaginal epithelium, externally by sinus epithelium, and between the two is compressed stroma. (Koff in Contributions to Embryology, vol. 23, Carnegie Institution of Washington.)

4. **Formation of the Vaginal Lumen.**—The epithelial cells in the center of the solid cord degenerate, desquamate, and are discharged in part through the hymenal opening. This process takes place caudocranially. The vaginal canal is thus formed (Fig. 275).

müllerian canal. Later, by their active growth, these cells lead to the formation of the so-called *vaginal bulbs.* These bulbs increase the area of vaginal contact with the sinus by their extension downward along its posterior wall. At the same time they invaginate this wall from behind so that the sinus undergoes a relative diminution in length. The hymenal site is thus made to approach nearer the surface."

While Nagel describes a bulging of the lower end of the vagina, bulb formation is not mentioned. Bloomfield and Fraser noticed these bulbs first at 79 mm. Had they made a more careful study of specimens from 50 to 70 mm., these structures would have been found earlier. They correspond in position and development to the structures designated above as sinovaginal bulbs, derived from the urogenital sinus. The evidence in favor of this latter contention is as follows: Previous to their appearance, the epithelium in the region of the müllerian tubercle and for a short distance caudally becomes highly stratified; the müllerian tubercle disappears as a result of bilateral, bulb-shaped evaginations from the posterior wall of the urogenital sinus in this region. The epithelium lining the sinovaginal bulbs is identical with that lining the urogenital sinus, except that the former becomes more highly stratified to occlude the lumen and form the solid lower segment of the vagina. The cells composing the tip of the uterovaginal canal show involutional changes. The ends of the wolffian ducts either disappear or migrate cranially as would be expected when the evagination of the urogenital sinus occurs.

Wood Jones (1904) believes, with Bloomfield and Fraser (1927), that the bulbs are derivatives of the müllerian ducts. According to him the fused müllerian ducts reach and open into the upper portion of the urogenital sinus at a 40-mm. stage. Later on, this opening is lost, to be regained at an advanced stage of fetal life. This second opening is brought about by a paired bulbar downgrowth from the fused müllerian ducts. The bulbs then tunnel their way through the mesoderm behind and parallel to the posterior wall of the urogenital sinus, to open at a much lower level than the müllerian tubercle, the hymen forming at the secondary opening in the posterior wall of the urogenital sinus. This view is distinctly unique in the history of development of ideas on the subject, since no investigator mentions its occurrence. In the specimens which Koff examined at the Carnegie Institute in 1933, no trace of a paired downgrowth posterior to the urogenital sinus and not in contact with the epithelium could be found. Moreover, once contact has been established between müllerian and sinus epithelium, it is always maintained by the development of the sinovaginal bulbs.

The second theory, namely, that the vagina is mainly müllerian but that a greater or lesser portion is formed from the wolffian ducts has been advocated by a number of investigators. Tourneut and Legay (1888 and 1889) presented this theory on the basis of study of human fetuses from 7.5 to 12 cm. They state that the "inferior extremities of the wolffian ducts participate in the formation of the genital canal by fusing with the müllerian ducts. As further evidence, it is stated that the wolffian ducts in bovines empty into the vagina."

Berry Hart (1901) considers that the upper two thirds of the vagina arises wholly from the fused müllerian ducts, while he ascribes to the "wolffian bulbs," which are solid bulbar thickenings at the caudal extremities of the wolffian ducts, the formation of the lower third of the vagina. Recently

reports a case in which both müllerian ducts were completely missing (absence of fallopian tubes, uterus, and upper two thirds of the vagina); in this case, however, the lower third of the vagina and the external genitalia were normally formed. He states "it is impossible to understand such malformations unless one grants that the upper and lower segments of the vagina are independent in their development."

DEVELOPMENT OF THE HYMEN

As stated earlier in this chapter, the hymen forms at the area of evagination of the urogenital sinus to produce the sinovaginal bulbs. The junction is guarded by an oblique lip which marks the future orifice of the vagina. These lips, one on each side, persist even after the sinovaginal bulbs have become

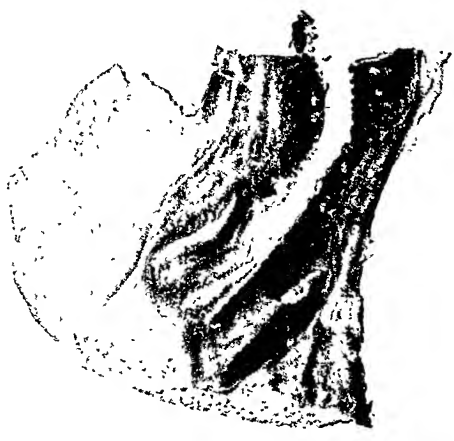

Fig. 277.—This is a photograph of a gross dissection of the lower portion of the vagina and urogenital sinus bisected sagittally, of a 250-mm. embryo magnified two and a half times. The vaginal epithelium is relatively thick. The hymen is large, and shows well-developed lateral folds (paired), and posterior membrane (unpaired). The clitoris and urogenital sinus are clearly shown in relation to the urethra and hymen. (Koff in Contributions to Embryology, vol. 23, Carnegie Institution of Washington.)

solidified, and the former become the anterior paired lips of the hymen. The posterior unpaired portion of the hymen develops in accordance with the increase in size of the caudal portion of the vagina. As this caudal end increases in size the roof or posterior wall of the urogenital sinus is invaginated. The connective tissue between the two (vagina and urogenital sinus) becomes compressed into a plate and forms the fibrous part or stroma of the unpaired segment of the hymen (Fig. 275). From the above description it follows, therefore, that the hymen is entirely derived from the urogenital sinus, since the lower end of the vagina is formed from the sinovaginal bulbs. These have been shown to be evaginations from the urogenital sinus in the region of the müllerian tubercle.

As the embryo elongates, the umbilicus and cloacal membrane become pushed apart, and cranial to the cloacal membrane a new portion of the ventral wall of the cloaca is formed. Corresponding to this, a portion of the anterior abdominal wall is formed. Somewhat later the anterior abdominal wall from the umbilicus to the caudal end of the cloacal membrane becomes pushed out to form an elevation. This elevation is termed the *cloacal* or *genital tubercle.* The cloacal membrane extends from the summit of the tubercle to the anus, while the newly formed portion extends from the summit of the tubercle to the umbilicus (Fig. 278).

With growth and curvature of the tail of the embryo the ventral division of the cloaca becomes subdivided into three portions. From the posterior portion the urethra and bladder are formed, the narrow middle portion becomes the *pars pelvina,* the broad ventral the *pars phallica* of the urogenital

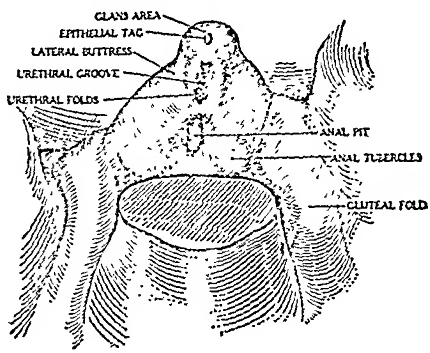

Fig. 278.—Drawing of external genitalia of an embryo 16.8 mm. long, illustrating the genital tubercle period. (M. H. Spaulding, Contributions to Embryology, vol. 13.)

sinus. The division takes place at approximately 12 mm. The last two divisions constitute the urogenital sinus, which extends from the müllerian tubercle cranially to the urogenital membrane caudally. From the posterior part of the pars pelvina is formed the lower portion of the vagina, as previously described, and from the pars phallica are formed some of the external genitalia.

DEVELOPMENT OF THE EXTERNAL GENITALIA

For the purpose of clarity the sequence of the development of the external genitalia may be divided into three periods: (1) The genital tubercle period, characterized by the more or less conical form of the genital eminence prior to the formation of the labioscrotal swellings; (2) the phallus period, beginning with the definite appearance of the labioscrotal swellings which separate the genital tubercle from the surrounding body areas; (3) the definitive period, characterized by the transition of the primary external genitalia into what is essentially their final form. Thus the genital tubercle is the parent tissue of the external genitalia.

1. **The Genital Tubercle Period.**—As described in the previous section the genital tubercle (cloacal tubercle) appears as a low conical eminence between the umbilical cord and the base of the tail (Fig. 278). We may distinguish on it an oral, anal, and two lateral slopes. Along the anal slope from the summit to the base of the tail, there is in the interior of the tubercle the pars phallica of the urogenital sinus, whose ventral wall, formed by the urogenital

and clitoris." The tip forms the glans, limited by the coronary sulcus from the lateral buttresses which form the shaft (Fig. 279, A and B). The urogenital opening becomes a narrow longitudinal orifice limited cranially by a pronounced epithelial tag. The margins of the urogenital opening, the urethral folds, become broad and eventually form the labia minora in the female. The most pronounced change is the development of the labioscrotal swellings as a pair of distinct, rounded ridges, one on each side of the base of the phallus and separated from it by a broad lateral phallic groove. These swellings eventually become the labia majora in the female, and the scrotum in the male. Spaulding believes these are developed from the outlying tissue, and

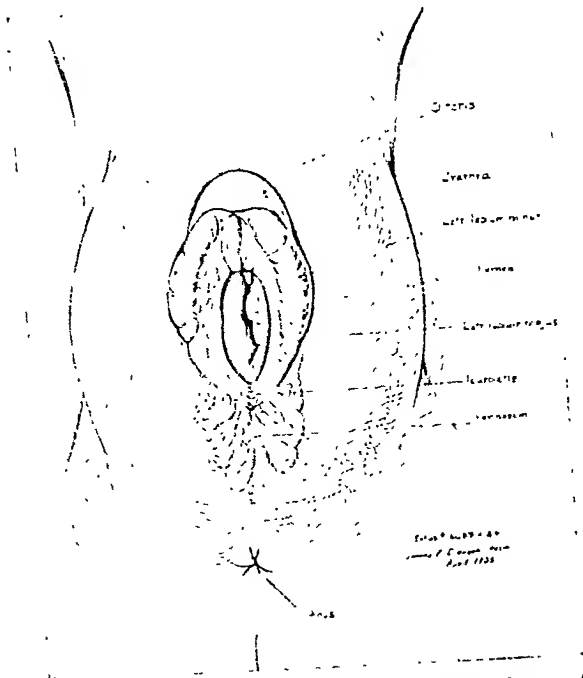

Fig. 280.—External genitalia of an eighth month female fetus. The urethral folds have become the labia minora between which projects the hymen and the urethral orifice. The phallus has become the clitoris, the glans here shown. The labioscrotal swellings have become the labia majora. The posterior commissure has become the fourchette. The urogenital opening has become the vestibule of the vulva. The area between anus and vestibule has widened to form the perineum.

not from the basal segment of the genital tubercle as Felix states. Herzog (1904) pointed out that at this period the phallus in the female has a caudal decurvation as an early sex difference. Another sex difference clearly seen at 24 mm. is that the urogenital opening in the female is limited to the shaft of the phallus, and does not extend to the tip of the glans as in the male (Fig. 279, A and B).

3. **Definitive Period.**—The important changes which result in the final differentiation of male and female external genitalia occur between the lengths of 38 and 45 mm. In the male the demarcation of the glans from the shaft soon becomes more pronounced than in the female. The most significant

proposed method of differential staining of germ cells, located what he identified as "extraregional germ cells" in the intestinal epithelium of the four weeks' human embryo. The supposed sex cells were arranged in such a way as to suggest an active migration from the entoderm of the gut, accompanying the visceral peritoneum.

Felix (1912) distinguished two categories of germ cells. These he designated as primary and secondary genital cells. The former, he contended, had a special origin from the segmentation cells, and were therefore extraregional in origin; that is, they arose directly from the blastomeres of early cleavage, and remained distinctly reproductive cells destined to migrate into the developing gonad. But these cells were found to degenerate and contribute nothing to the definitive germ cell population. The secondary genital cells Felix believed were derived from the peritoneum on the gonads, and there passed through growth and maturation processes into ova or sperm, as the case might be. The two categories of cells, however, had no genetic relation.

De Winiwarter and Sainmont (1909), from studies of germ cells of embryos of kittens, also maintained that the primordial germ cells in the cat all degenerated and were replaced by a local proliferation from the germinal peritoneum. De Winiwarter later (1910) declared that a like fate could be demonstrated for primordial germ cells in man.

Thus, it is admitted by many that the so-called "primordial germ cells" do appear in early embryonic stages and when first distinguishable are located in the gut entoderm. From here they migrate to the genital ridge, such cells being the preprimordium of the gonad. However, a number of recent investigators (Hargitt, Simkins, and Kohno) deny early segregation of germ cells, and believe that germ cell formation is a matter of differentiation of somatic cells (the peritoneal epithelium in man). A second group (Kingsbury, 1913; Butcher, 1927, and others) admit early segregation of germ cells, but conclude that these degenerate to be replaced by proliferations of new cells from the germinal epithelium. A third group, including Bohi (1904) and E. Allen (1922, 1923), support the conclusion that germ cells are set apart early, migrate to the site of the developing ovary and testis and persist, their numbers being increased periodically by a proliferation from the peritoneal or coelomic epithelium. Allen, from careful studies of the oestrous cycle of the white mouse, was led to the conclusion that at each normal oestrous period young ova were added to the cortex of the adult ovary. He described them as arising from the germinal epithelium. From observations on the guinea-pig, cat, and dog Evans and Swezy (1929) conclude that ovogenesis occurs throughout adult life as a rhythmical process, and that during the lifetime of the individual literally thousands of ova are produced *de novo*. Though it is difficult to make this correlation in man because of a lack of knowledge of the cycle, Swezy and Evans (1929) believe that ultimately similar changes will be found to occur in man as well as other animals.

In man, Felix states that in early embryos (2.6–4 mm.) primordial germ cells (genital cells) do exist but eventually degenerate, to be replaced by proliferations of new cells from the germinal epithelium of the genital fold.

The development of the ovary can be divided into two stages:

1. The indifferent stage.
2. The stage of sexual differentiation and transformation.

hilum of the genital gland. We shall describe later the importance of the latter arrangement in the formation of the rete testis and rete ovarii.

The indifferent stage of the reproductive gland lasts only a short time. During this period the uniform epithelial mass of the genital fold separates into a superficial epithelium and an inner epithelial mass. The superficial epithelium retains its closed epithelial structure and consists of from one to two layers. The inner epithelial mass becomes looser in texture, so that at the end of the indifferent stage its epithelial origin is no longer evident (Fig. 281).

Sexual Differentiation.—In the differentiation of the sex gland the primitive genital cells become either spermatogonia or oogonia, and the gland therefore becomes either testis or ovary. Moreover, it is not uncommon that a reproductive gland may assume the characters of a testis without forming spermatogonia, as in the case of the cryptorchid, or that there may be scattered ova in testicular tissue, or testicular cords in the ovary. In some of the lower animals, fowl for example, differentiation is often incomplete, the testis always containing some female genital cells. When this occurs there is usually bisexuality of the secondary sex characteristics (Goodale).

Transformation of the Indifferent Gland into the Testis.—The epithelial cell mass beneath the superficial epithelium forms the tunica albuginea, the testis tubules and the rete testis, the superficial epithelium playing only a passive rôle, growing in importance with the enlargement of the organ.

The loose epithelial mass, at about 14 mm., concentrates in certain places, and the cells rather suddenly arrange themselves to form anastomosing cords (Fig. 282). The latter are arranged transversely to the long axis of the testis, their inner ends concentrating at the hilum to form a closely aggregated epithelial mass, the precursor of the rete testis. At the boundaries between the cords there occurs at 20 mm. a distinct formation of connective tissue sheaths. The lumina of the solid testis cords appear at about the seventh month, and arise partly by migration of the cells from the center of the cords to the periphery and partly by their resorption. The lumen, appearing first at the periphery of the cords, gradually extends toward the hilum, and a second lumen extends from the rete testis along the tubuli recti toward the first one. The two meet, and thus the testis tubules, the tubuli recti and the rete tubules become hollow. The tunica albuginea appears simultaneously with the formation of the testis cords, and represents the cortical portion of the early epithelial mass which is not traversed by the cords, and which evidently has become transformed into connective tissue.

All the testis cords are not transformed into tubules at birth. According to the observations of Branca and Basseta, the number of genital cells increase progressively from the fifth month to birth. After birth the genital cells become fewer in number, but with the onset of puberty a new generation is formed which then enters upon the formation of spermatozoa.

Transformation of the Indifferent Gland into the Ovary.—The indifferent gland consists of an epithelial mass and a superficial epithelium, sharply separated from each other (Winiwarter and Sainmont, 1909). However, between 70 and 80 mm. the superficial epithelium comes into close relationship with the epithelial cell mass beneath. Some authors claim that this new relationship means the formation of new cells which may form ova. The actual reproductive gland is developed from the epithelial cell mass beneath the

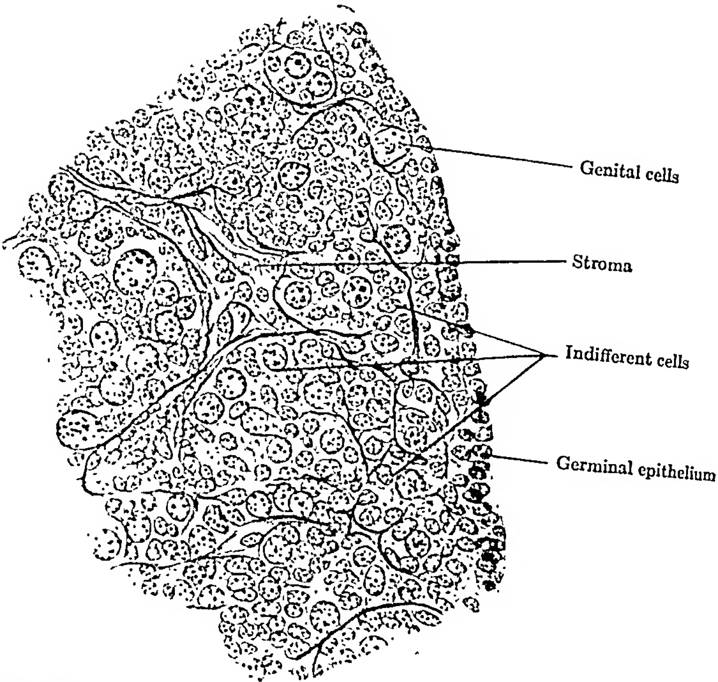

Fig. 283.—Cross section through the ovary of a three and one-half months' human embryo (140 mm.). (After Fischel.)

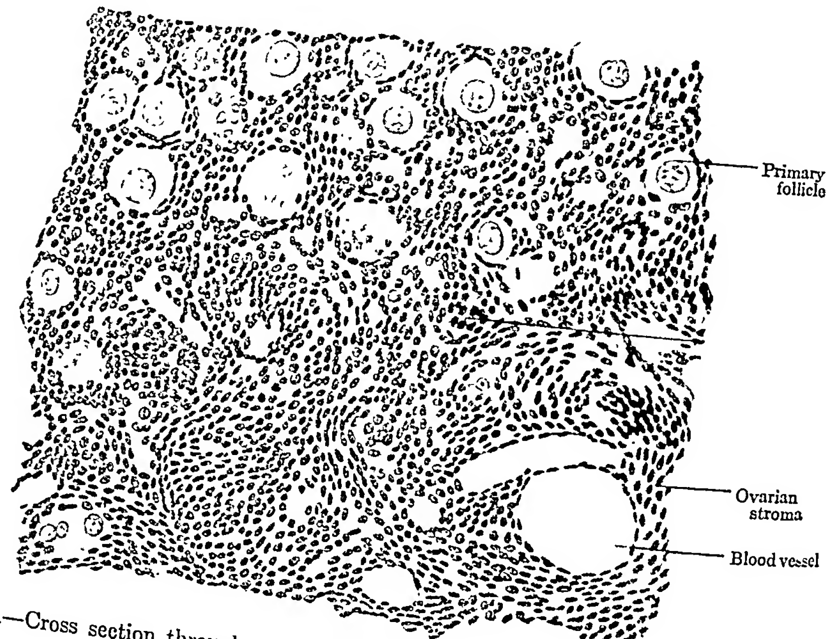

Fig. 284.—Cross section through cortex of ovary showing primary follicles and stroma (× 183; 8 mo.). (After Felix.)

the rete loses its connection with the epithelial cell mass, and a definite layer of connective tissue is laid down between the rete and the functional portion of the ovary. As a result of this, the rete cords often acquire a lumen, and the tubules thus formed are found to end blindly toward the ovary. As stated

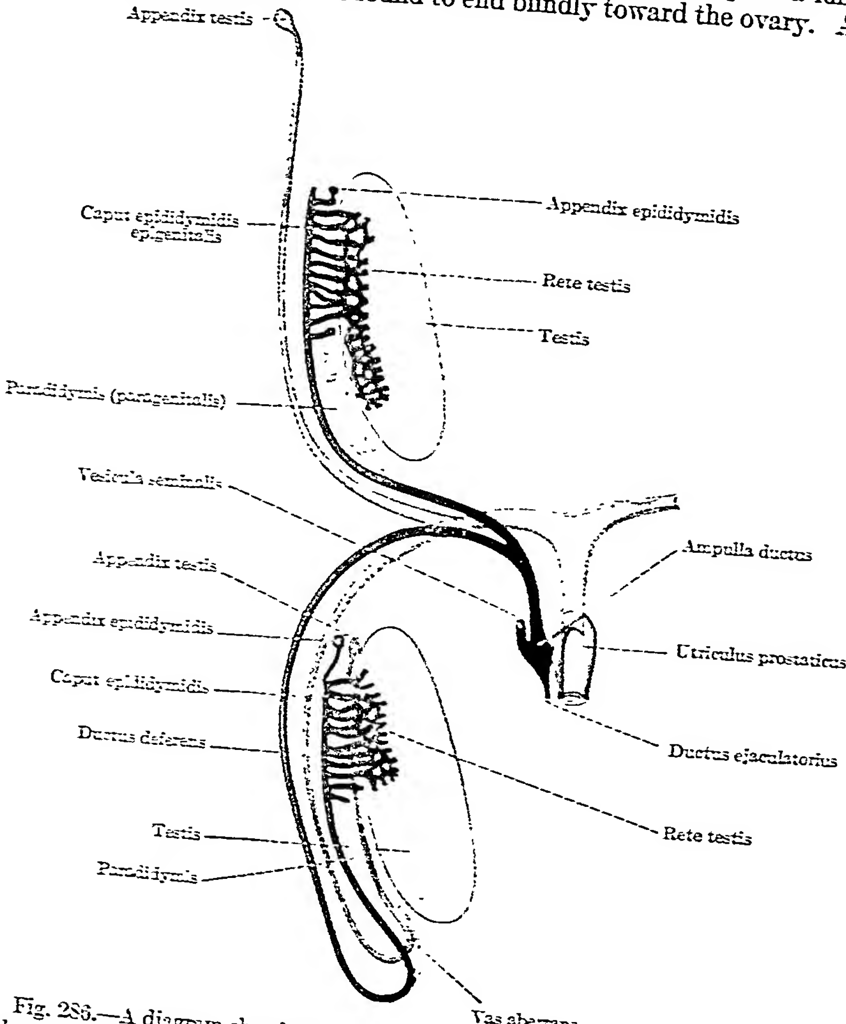

Fig. 286.—A diagram showing the relationship of the testes to the wolffian duct, mesonephros and müllerian duct. The testis wanders from the body cavity into the scrotal sac (descensus). The müllerian duct degenerates throughout, except that the closed ostium abdominale persists as the appendix testis, and the lower portion as the utriculus prostaticus. All the tubules of the epididymis do not unite with the rete testis. The first ends blindly to form the appendix epididymis, the remainder form the epididymis proper. The caudal portion of the mesonephros forms the paradidymis. The wolffian duct persists to form the ductus deferens. (After Felix.)

earlier in this chapter, in the course of involution of the mesonephros certain of the glomerular capsules and their corresponding tubules in the cranial portions of the mesonephros are preserved. These later develop into the epoöphoron in the female, and into the epididymis in the male. The number of tubules taking part in the formation of these structures is variable (6 to 12).

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CHAPTER XVIII

PRESENTATION AND POSITION OF THE FETUS

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Labor is a mechanical process. The successful termination of labor depends upon the powers of labor, the relative size of the fetus and the birth passages, and the manner in which the fetus must traverse the birth canal. Presentation and position determine the manner in which the process is to be carried out. An accurate diagnosis of presentation and position is of the utmost importance in the intelligent management of labor.

HABITUS

By habitus or attitude is understood the relation of the fetal parts to each other without reference to the uterine walls. In normal habitus, the head and the extremities lie in a definite relation to the longitudinal axis of the fetal body. The spinal column is bowed forward, the head flexed with the chin against the sternum, the arms flexed, and folded across the chest. The joints of the lower extremities are all flexed, the thighs on the abdomen, the lower legs on the thighs and the feet on the lower legs. This attitude is due to the mode of growth or development of the fetus, and in the later months of pregnancy is influenced by the shape and size of the uterine cavity. The fetus assumes a roughly ovoid shape, and therefore occupies the smallest possible space and conforms to the concavity of the uterus. In this attitude it is about half as long as if it were completely stretched out. The occiput forms one pole of the ovoid and the breech the other. The longitudinal axis of the fetus is the line joining the occiput and breech.

In this normal habitus the fetal body, at least in the early months of pregnancy, may move freely in the uterine cavity, as a mass surrounded by amniotic fluid, and often varies in location according to the posture of the mother. In the course of development, we shall see that, although the general disposal of the fetus may change in regard to the uterine axis, its habitus does not alter significantly but remains practically constant throughout the pregnancy. The habitus, however, is not fixed and rigid. Warnekros has shown by roentgenographical studies that the normal habitus is not so constrained as was formerly believed. He observed much diversity in the amount of flexion of the extremities, considerable variation in the straightening of the back and in flexion and deflection of the head. Warnekros also believes that the fetus lies naturally in the uterus with the head in moderate flexion, the back straightened in about the same position that it would assume outside the uterus. Allowing for such variations, the general ovoid form of the fetal body corresponds to the general ovoid shape of the uterine cavity. Then, as pregnancy draws to term the breech occupies the more roomy fundus and the head is well adapted to the shape and size of the lower uterine segment and the region of the pelvic inlet.

The habitus of the fetus may determine the presentation.

down and he concluded that the difference in weight between the head and breech did not sufficiently account for the great frequency of head first labors.

Dubois and Simpson, repeating the fetal immersion experiments, found that the shoulder sank to a lower point than the head. These findings, together with the fact that the uterus has not the spatial capacity of a free vessel in which the fetus can move unhampered, suggested that other factors than gravitation were necessary to explain the great frequency of head presentations. Such factors are supplied by the so-called *accommodation theory* of the relationship between the fetus and uterus, sponsored particularly by Simpson and now almost universally accepted. The accommodation theory is based on Pajot's law, which is as follows: "When a solid body is contained in another, if the container is the seat of alternate movements and repose, if the surfaces are slippery and not angular, the contained body constantly tends to accommodate its form and dimensions to the form and capacity of the container." This theory means that the fetus lies most suitably, both for itself and for the uterus, when its head end is turned downward, since the fetal ovoid then fits best into the ovoid form of the uterus. The fetal body, also being ovoid in shape, with the pelvic end larger than the cephalic, finds the fundal portion of the uterus much more convenient for the breech than the narrower lower segment. The roomy fundal part also allows for possible movements of the fetal extremities. Thus fetal movements and the contractions of the uterus in pregnancy contribute reciprocally in the adjustment of the fetus to the shape of the uterine cavity. As the fetus grows, the space for fetal movement becomes progressively less, the head remains more suitably in the lower uterine segment and head presentations are the most frequent.

We may now resume consideration of the two major divisions of presentation—the longitudinal (head or breech) and the transverse. For purposes of accurate description, these major divisions are further subdivided.

Cephalic presentations are divided into several varieties depending upon the relation which the head bears to the body of the child. In the usual attitude with the chin in contact with the chest, the vertex is the presenting part, a *vertex presentation*. In this, the smallest diameters of the head are in correlation with the appropriate pelvic diameters and the mechanism of descent and flexion is favored.

But the head may present not in the normal attitude of flexion but in various degrees of deflection, wherein the chin is removed farther and farther from the breast. With the head in partial flexion the large fontanel lies near the center of the pelvis, the sinciput presents, *sincipital presentation*. With further deflection the *brow* becomes the presenting part, the largest diameters of the head are obliged to pass the pelvic canal which is usually impossible. In extreme deflection with the occiput against the back, the *face* is the presenting part; in this the diameters are less than in brow presentation and spontaneous delivery usually occurs.

Breech presentations also show certain variations. Unlike cephalic presentations, the mechanism of labor is essentially the same in all varieties of breech presentation. With both knees flexed the buttocks and feet lie at the same level, *double* or *complete breech*. If the thighs are flexed on the abdomen with the legs lying straight along the chest, the result is a *single breech* or *frank breech*. When one or both feet come down it is called a *footling presentation*.

Fig. 290.—Vertex presentation. Occiput left posterior. (Bumm.)

Fig. 291.—Vertex presentation. Occiput right posterior. (Bumm.)

Fig. 294.—Breech presentation. Sacro left anterior. (Bumm.)

Fig. 295.—Breech presentation. Sacro right posterior. (Bumm.)

2. Face—chin, the point of direction.

Mento-laeva anterior	M. L. A.
" laeva transversa	M. L. T.
" laeva posterior	M. L. P.
" dextra anterior	M. D. A.
" dextra transversa	M. D. T.
" dextra posterior	M. D. P.

3. Brow—the brow, the point of direction.

Fronto-laeva anterior	F. L. A.
" laeva transversa	F. L. T.
" laeva posterior	F. L. P.
" dextra anterior	F. D. A.
" dextra transversa	F. D. T.
" dextra posterior	F. D. P.

PELVIC OR BREECH PRESENTATIONS

1. The sacrum, the point of direction.

Sacro-laeva anterior	S. L. A.
" laeva transversa	S. L. T.
" laeva posterior	S. L. P.
" dextra anterior	S. D. A.
" dextra transversa	S. D. T.
" dextra posterior	S. D. P.

TRANSVERSE PRESENTATIONS

1. Shoulder—the scapula, the point of direction.

Scapulo-laeva anterior	Sc. L. A.	Back anterior positions
" dextra anterior	Sc. D. A.	
" dextra posterior	Sc. D. P.	Back posterior positions
" laeva posterior	Sc. L. P.	

It has already been stated that about 99.5 per cent of all presentations are longitudinal and that of these from 96 to 97 per cent are cephalic. Jellett and Madill state that in the Rotunda Hospital, Dublin, 96.22 per cent of all labors occurring after the fourth month were vertex presentations. Experience has shown that the left-occipito-anterior presentation (O. L. A.) is by far the most common type, the right-occipito-posterior (O. D. P.) coming next. So preponderatingly frequent is the first named that it may be accepted as the normal presentation of the human fetus. Physiologically, it offers the best chance for a spontaneous and safe delivery.

An analysis of the reports of 375,335 deliveries by various authors shows that the vertex (O. L. A. or O. D. P.) presented in 95.6 per cent. Of these, 70.96 per cent were left-occipito-anterior (O. L. A.) and nearly 25 per cent were right-occipito-posterior presentations (O. D. P.).

The breech presents in about 3 per cent of all labors and the face and transverse (shoulder) each occur in less than 1 per cent of all cases.

Causes Which Influence Position of the Fetus.—The reason for the predominance of the anterior positions of the back is found in the shape of the cavity of the uterus, the anterior wall of which presents a concavity into which the convexity of the back of the flexed fetus conveniently rests. At the same time the more or less straightened outline of the ventral aspect of the fetus adjusts itself to the flatter surface of the posterior wall of the uterus. The transverse diameter of the cavity of the uterus is somewhat longer than the anteroposterior diameter. The uterus is rotated on its long axis

verse, a longitudinal ovoid. In multiple pregnancies and hydramnion the abdomen is relatively broader with all diameters increased. In transverse presentation the lower pole is broader and the fundus relatively lower. The ovoid is transverse or oblique.

The abdominal palpation is made systematically, with the patient on her back, thighs flexed. The height of the fundus is noted in fingerbreadths or centimeters below the ensiform cartilage. The hands, laid on each side of the abdomen with moderate pressure, determine whether the ovoid is longitudinal or transverse. Identification of the upper fetal pole follows. The

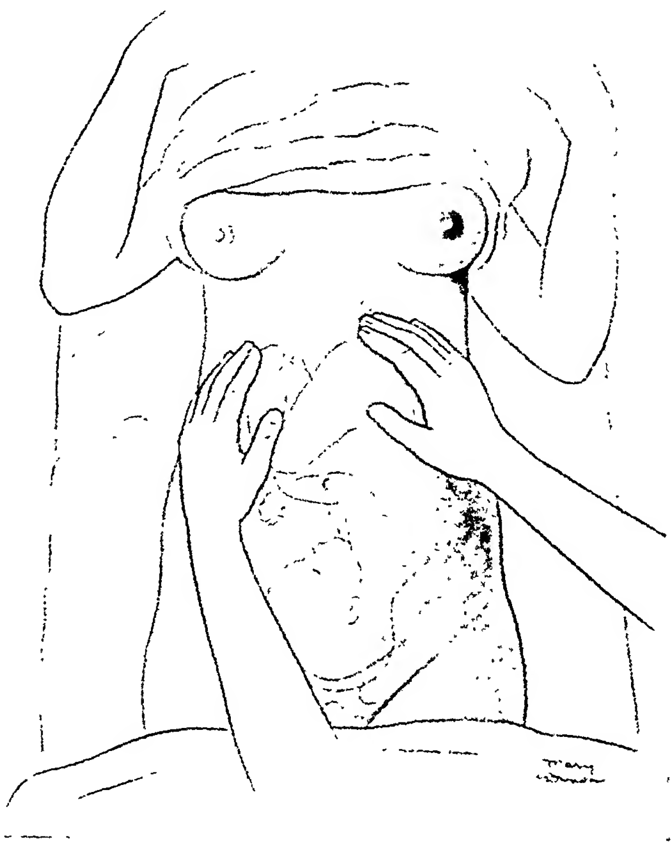

Fig. 297.—Identification of the upper fetal pole.

breech is soft and irregular and when moved the body moves correspondingly. The breech is not ballottable. The head is hard, smooth, and round. In favorable cases a depression indicating the location of the neck may be made out. The most useful method for recognizing the head in the fundus is by ballottement between the fingers of the two hands or between the thumb and fingers of one hand. This may be the only means of identifying the head in this location. The lower fetal pole is examined next. The tips of the fingers are gently pressed downward and inward just above Poupart's ligament on each side, to palpate the presenting part. The head is hard, smooth,

lies. In posterior positions it occupies a place on the same side as the back but away from the midline, toward the flank.

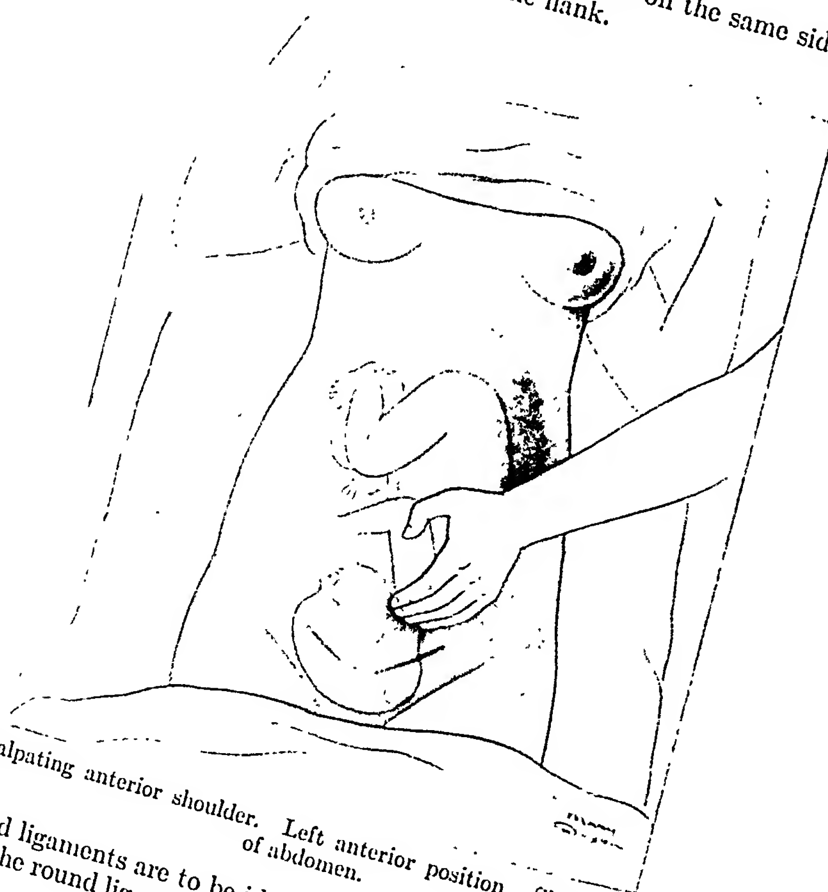

Fig. 299.—Palpating anterior shoulder. Left anterior position. Shoulder near midline of abdomen.

The round ligaments are to be identified next. In from 60 to 70 per cent of the cases, the round ligament is most prominent on the side where the back

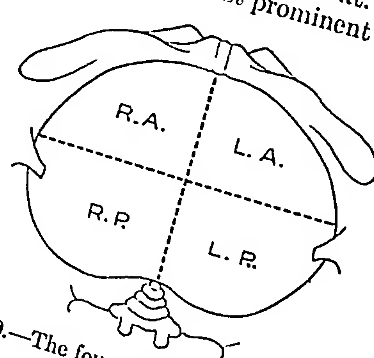

Fig. 300.—The four quadrants of the pelvis.

lies. These structures may be felt as small round cords extending from the internal inguinal rings upward and outward on the sides of the uterus. The

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Five points are used to diagnose the location of the back. The cephalic prominence is on the side opposite to the back. The small parts in the fundus are on the side opposite to the back. The round ligament is usually most

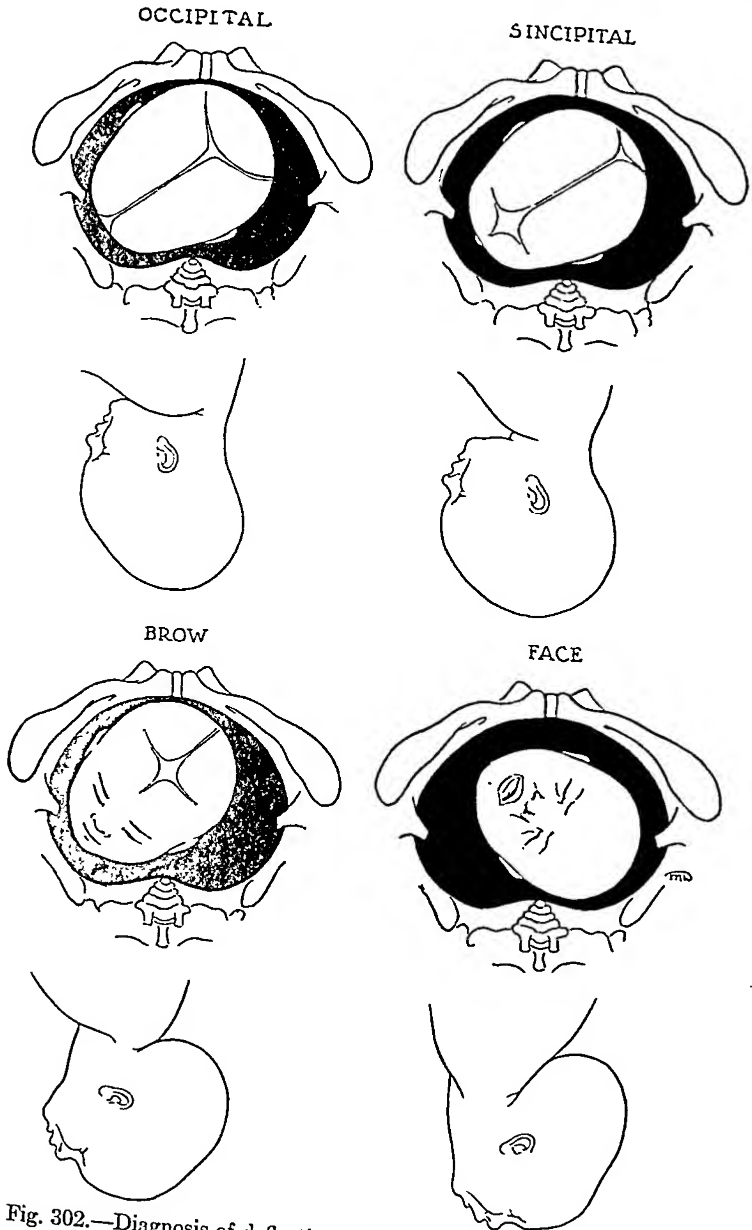

Fig. 302.—Diagnosis of deflection attitudes by internal examination.

prominent on the side where the back lies. The anterior shoulder is always on the same side as the back. The greatest intensity of the fetal heart tones is also on the same side. The anterior shoulder gives some indication of position: if it is near the midline of the abdomen in vertex presentations, the

head lies. The scapula is always anterior or posterior to the transverse diameter of the pelvis and in one of the quadrants toward the side on which the head lies. The quadrant in which the scapula is found names the position: scapula right or left, anterior or posterior.

When the face presents, the orbits and the chin lie in opposite sides of the pelvis and the chin is the point of direction. The location of the chin in one of the four quadrants names the position.

in pregnancy is yet to be determined. Taking everything into consideration, it seems probable that *intermittent spasms of the renal arterioles* may initiate the condition in question (posterior pituitary effect [?]).

The perfection of the technic of pyelography during recent years has been productive of valuable information concerning the condition of the *renal pelvis and the ureter* during pregnancy. Further information came from careful microscopical studies of specimens of the urinary tract, obtained at autopsy. Previous investigations carried out with the old *x*-ray technic together with certain recent experimental findings have supplemented these data.

Within recent years two facts have become firmly established, namely, the frequent occurrence of ureteral dilatation and a certain degree of lack of ureteral tonus in pregnant women. While former investigators (Olshausen *et al.*), studying the gross appearance of the ureter at autopsy, reported that dilatation occurred in 19 per cent of their series, modern methods of examination, particularly pyelograms taken after the insertion of ureteral catheters, reveal an incidence of about 80 per cent (Kretschmer and Heaney, Frank Kidd *et al.*). Since the information derived from such observation does not harmonize entirely with the actual condition of affairs, by reason of the stimulating effect of an artificially introduced foreign body on the ureter, intravenous pyelography (uroselectan) has been tried by Schumacher, and others. In our present state of knowledge, we may reasonably conclude that pictures obtained by this method actually portray the essential condition of the urinary tract with a fair degree of accuracy. The significance of the findings thus obtained in 100 normal pregnant women is reflected in the statement that dilatation of the abdominal portion of the ureter with loss of tonus occurred in every single instance, and appeared to be a bilateral phenomenon in 83 per cent of the cases examined. These changes were noticeable as early as the third month and became more evident with the advance of pregnancy. No relation between the various positions and presentations of the fetus and the occurrence of ureteral dilatation could be established. In 15 out of 100 cases examined there was no involvement of the left ureter. Along with the dilatation, there appeared an outward displacement, probably by the pregnant uterus, of the lower half of the abdominal part of the ureter, which was found, in a large majority of cases, to be now situated close to the outer margin of the psoas muscle, while the pelvic portion of the ureter essentially maintained its topography. Dilatation of the ureter is accompanied by a corresponding lengthening of the tube. The arched curve of the abdominal ureter may be partly due to this excess length. Ureteral dilatation both in primigravidae and in multiparae, may attain a diameter of 1.5 to 2 cm.; under such conditions some gravidae may complain of constant aching pains in the lumbar region or in the lower abdomen. Dilatation of the pelvic portion of the ureter is appreciable in a certain number of normal pregnant women. In 50 per cent of cases with a superimposed urinary infection a marked dilatation of the pelvic ureter occurs. S-shaped kinking of the ureter, just beneath the kidney pelvis or within its upper third, was seen in about 80 out of 100 cases examined. The capacity of the renal pelvis and of the ureter in the latter part of pregnancy varies from 32 to 84 cc., as contrasted with normal figures in the neighborhood of 15 cc. Figures 303 to 305 illustrate the conditions of the ureter in normal asymptomatic gestation.

Another almost constant physiologic concomitant of pregnancy is a cer-

tain degree of lack of tonus of the ureter, as evidenced by a marked delay in the excretion of injected dyes and a prolongation of the contraction intervals of ureteral peristalsis (Kaltenschnee, Pugh).

The structural changes of the ureter in pregnancy have been studied in recent years with a view to ascertaining, if possible, the existence of some obstructive lesion in its lower portion. In the course of these studies, we noted peculiar hyperplastic and hypertrophic changes both in the musculature and in the connective tissue of the pelvic portion of the ureter. Such hypertrophy is particularly pronounced in the juxtavesical region, where the ureter passes through the parametrium and lies in close contact with both the bladder and the anterior vaginal vault. It is characteristic that hypertrophy of the constituents of the ureter within its abdominal portion, although still noticeable, is decidedly less marked than in its lower portion.

Fig. 305.—II gravida. IX menses. Fetus in R. O. A. Bilateral dilatation of renal pelvis and ureter. Kink formation of the ureter below the ureteropelvic junction.

Figure 306 shows a section through a ureter at term, 2 mm. above its junction with the bladder. The most important feature of this picture is the excessive hypertrophy of the ureteral sheath. This hypertrophy, although invariably present, varied within certain limits in the specimens examined. Quite often the diameter of the ureteral sheath equaled or even exceeded the diameter of the ureter itself, cleavage being visible between the two structures. In addition, the architecture of the entire ureteral wall appears changed, owing to the presence of a considerable amount of fibroblastic tissue interspersed between the hypertrophied muscle bundles, thus creating a rather rigid structure. When compared with a normal ureter, the difference both in the thickness of the muscle bundles and the development of connective tissue can be readily seen (Figs. 307, 308). The ureteral mucosa

mononuclear cells in process of wandering through the epithelium make an interesting phenomenon.

As a consequence of the interlacing of hypertrophied muscle bundles and hyperplastic connective tissue, the whole ureter gives the impression of a rather rigid organ with narrowed lumen due to constriction effected both by the structural alterations in its wall and by the encircling sheath. These conditions might readily give rise to stenosis in the juxtavesical region of the ureter. Confirmation of our findings is afforded in the recent studies of D. Baird *et al.*, and also by the clinical observation first noted by Saenger, that the ureters can be definitely felt on bimanual palpation during the second half of pregnancy.

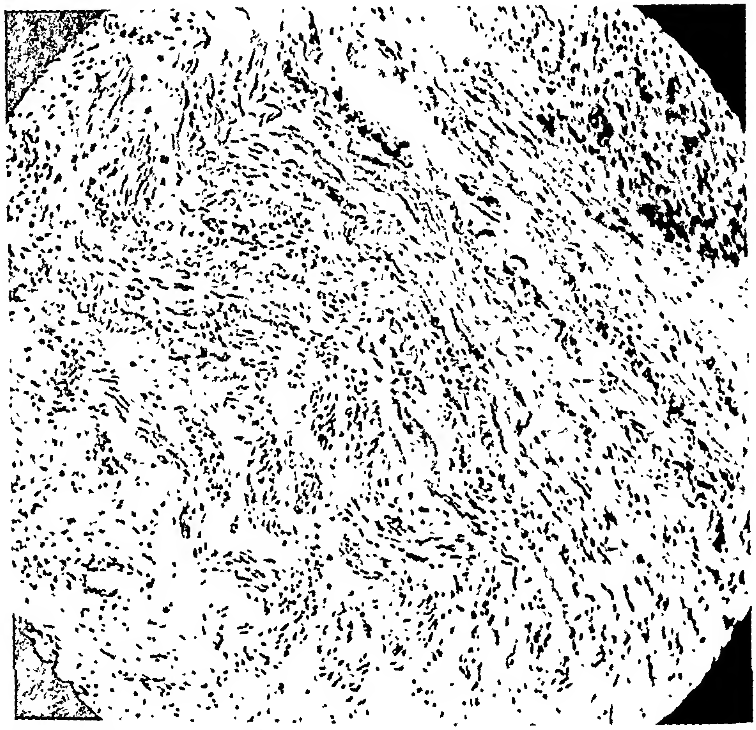

Fig. 308.—Photomicrograph of ureter of a nonpregnant woman, showing arrangement of musculature and delicate connective tissue in the ureteral wall (× 15).

In stressing the primary importance of the hyperplastic and hypertrophic changes in the lower part of the pelvic ureter as essential factors in the narrowing of its lumen in pregnancy we, in no sense, underestimate the significance of mucosal congestion and edema as contributory factors, since prevailing doctrines indicate that such occurrences may turn the tide and render positive the hitherto potential obstruction of the ureter. More significant, however, in this regard, appears to be the development of an angulation of the right ureter at the distal end of its juxtavesical portion, in consequence of the common dextrorotation of the pregnant uterus and the firm attachment of the trigonum vesicae to its cervical portion; the same process predisposes to stretching of the left ureter.

the back-pressure to which it is subjected, may have an impairing, if transient effect upon the function of the kidney itself. Release of pressure in the kidney is followed by an improvement in renal function (Baird). A final point is that the variable distensibility of the ureter may depend in great measure upon the specific condition of the connective tissue of the ureteral wall in different localities. It is worthy of note that within twelve weeks after delivery, in uncomplicated cases, ureteral abnormalities tend to subside to normal. The rate at which such retrogressive changes take place is in proportion to the degree of distention during gestation.

Consistent with the specific structural changes noted both in the juxtavesical and the intravesical portion of the ureter, there occurs during pregnancy a definite thickening of the entire *trigonal muscle of the bladder*, from the interureteral ridge to the vesico-urethral orifice. This hypertrophy is most pronounced in two different localities, in the interureteral ridge and adjacent to the vesical orifice. It is associated with an edematous imbibition of the interstices between the individual muscle fibers. Another essential alteration in the structure of the trigonum consists in the increase in number and size of the elastic fibers and a condensation of the connective tissue resulting from a considerable development of young fibers, the trigone becoming converted into a dense and unyielding structure. Owing to the development and the distention of the lower uterine segment, the base of the bladder is gradually displaced anteriorly and upward. Attention is also drawn to the engorgement of the small vessels and to a more or less distinctly visible edema within the mucosa. The demonstration of such substantial changes in the anatomy of the trigonum in pregnancy may serve to elucidate the fact that, on cystoscopical examination in pregnant women, the entire region of the trigonum frequently appears somewhat protruding and Mercier's bar is particularly well marked; congestion of the mucosa is most pronounced in the region of the trigonum. Hypertrophy of the trigone with a prominent plica ureterica also affords a satisfactory explanation of the fact first noted by Curtis, that retention of several ounces of residual urine is often demonstrable during pregnancy, while hyperemia of the trigone may account for frequent urination during this period.

x-Ray examination of the suprapubic region reveals the interesting fact that during the last few months of pregnancy, upward displacement of the bladder becomes so pronounced that the bladder seems an abdominal rather than a pelvic organ and is tilted to the right, corresponding with the torsion of the pregnant uterus about its vertical axis.

ALIMENTARY TRACT

In this field, the obstetrician faces problems which make him acutely aware of the insufficiency of present knowledge; indeed the condition of the digestive system during pregnancy has been singularly neglected in the past.

Hyperemia of the gums, associated with various degrees of edema and hypertrophy, is noticeable from the fourth month of pregnancy in about 30 per cent of normal gravidae. Excessive salivation may accompany this process in rare instances.

Decrease in the amount of gastric hydrochloric acid is rather common in pregnant women. Serial *x*-ray studies of the stomach in pregnancy reveal augmented motility, associated with increased irritability, as a character-

such conditions the vocal cords are prevented from coming into close apposition during speech. In former days such occurrences in the interarytenoid region during pregnancy were often mistaken for tuberculous involvement. The changes detailed above may become accentuated under the strain imposed during labor. On the other hand, such changes subside entirely within ten days after delivery.

The laryngeal phenomena offer an adequate explanation for the well-known fact that pregnancy may alter and sometimes even injure the voice of professional singers.

The mucosa covering the nasal inferior turbinate shows a markedly increased vascularity and a dilation of its lymph channels during pregnancy. The nasal application of pituitary extract for the induction of labor at term, and also for the stimulation of lingering uterine contractions during labor, is based on our knowledge of these structural changes.

In recent years, we have gained more intimate knowledge of the finer anatomy and histology of the lungs during gestation. Here, also, three essential features may be noted: Hyperemia, edema associated with increased lymph formation, and remarkable aggregation of lymphoid tissue in close proximity to the smaller bronchi. Such changes resemble those in the larynx of pregnant women and, to some extent, those noticeable in the lungs of children as an aftermath of measles and influenza. Because of their importance in pulmonary tuberculosis, they may deserve consideration in two respects. In the first place, the clinical observation that pregnancy tends to accelerate certain types of tuberculosis may be explained by the pulmonary conditions noted above, since edematous imbibition of the indurated zones, which surround and wall off tuberculous areas like a protecting barrier, may pave the way for a dissemination of the pathogenic bacilli. And, further, since tuberculosis establishes itself, above all, in lymphoid tissue, the newly formed areas may constitute *foci minoris resistentiae*.

BLOOD AND CIRCULATORY SYSTEM

Much has been written of late concerning alterations of the various constituents of the blood during pregnancy. A perusal of the literature on the subject reveals the difficulty of a proper evaluation of the many conflicting views on this theme.

Remarkable observations have been made concerning the *lowered resistance* of the pregnant organism against infection, as evidenced by a marked decrease in the immune reaction of the serum. Koessler and Neumann, in studies conducted in the Vienna Clinic, claim to have ascertained both a decided lowering and an instability of the opsonic index of the serum toward the tubercle bacillus during pregnancy. From clinical and experimental data obtained in infectious diseases, P. Bar concluded that the pregnant organism should be regarded as in a state of "passive anergy." Sano's experiments show that in the second half of pregnancy, there occurs a marked lowering of resistance against various types of infection. The immunological conditions obtaining in pregnant women with regard to Bacterium coli have been studied by the writer. It was found that the decrease in the immune reaction is by no means an invariable concomitant of pregnancy, as an abrupt fall in the opsonic index occurs in about 11 per cent only of the cases examined. Bonney and Douglas also emphasize the considerable variability

The preponderance of evidence indicates a remarkable increase of the blood volume in pregnant women. This factor, taken in conjunction with the demands of the enlarging uterus and its contents, imposes augmented work on the heart during gestation. The increase in body weight, the displacement and rotation of the heart and the tendency of the arterioles to contract are additional factors which tend to embarrass the circulation. The reaction to this superadded strain is noticeable as hypertrophy and slight dilatation of the heart, the average increase of weight amounting to 22.5 Gm. *x*-Ray pictures show, in approximately 50 per cent of normal pregnant women, an increase in both the longitudinal and the transverse diameters of the heart. Toward term the heart becomes displaced upward in such a way that it assumes a more transverse position, the area of dulness being considerably increased. The functional changes are usually slight. In a certain percentage of cases, however, the cardiac manifestations may simulate organic disease (Gammeltoft). Symptoms indicative of a functional change include tachycardia, extrasystoles, systolic and diastolic murmurs at the base of the heart. It has been amply demonstrated that these manifestations of functional disorder disappear entirely within the first few weeks of the puerperium (Mackenzie). It may be that a mild hyperthyroidism accounts for the functional aberrations of the heart during pregnancy, for their subsidence coincides with recession of the enlargement of the thyroid gland. The cardiac reserve is fully maintained during pregnancy and labor. Normal pregnancy produces no significant changes in the electrocardiogram: while the demonstration of defective conduction in the gravid patient is an immediate objective indication of profound disturbance of the cardiac mechanism (King). Extensive use of modern functional tests for determining the status of the myocardium may suggest a satisfactory explanation for the clinical observation that permanent damage of the myocardium, with demonstrable degenerative changes, may sometimes result from repeated pregnancies.

The consensus of opinion is that the cardiac output in pregnant women is increased (Gammeltoft, Weiss). Recent studies of Schmidt tend to show that during the fourth month of pregnancy, this increase may amount to 25 per cent; while with advancing pregnancy a further rise occurs, amounting at term to 50 to 60 per cent. Since there is no appreciable change in blood pressure readings during normal pregnancy, the increased cardiac output is apparently counterbalanced by a dilatation of the capillary bed, as demonstrated by the researches of Hinselmann. Recently, different writers have drawn attention to an increased permeability of both the capillaries and the choroid plexus during the last few months of gestation. Evidence in support of this view is not entirely convincing at present, so the validity of these statements must be determined by further research.

HORMONAL SYSTEM

During the past two decades, there has been elaborate investigation of the relationship of pregnancy to the ductless glands. From the enormous literature which has accumulated on this all-important subject, one is apt to get the impression that our knowledge in this field is detailed and satisfactory. In reality, our understanding of these relationships is only in its beginning and, in our present stage of knowledge, it is impossible to answer

the administration of pituitary extracts to laboratory animals, has given plausibility to correlations of this type in pregnant women. The following experimental results, obtained under well-controlled conditions, appear sufficiently established to warrant their application to similar conditions during gestation. The irregular-shaped plaques of newly formed bone, or osteoid tissue, observed upon the internal surface of the cranial bones during pregnancy (Rokitansky's "puerperal osteophytes") find their analogue in structures which develop upon the inner aspect of the skull of dogs after repeated intraperitoneal injections of anterior pituitary extract (Putnam). Associated with increased activity of the anterior pituitary body we find also increase of the cholesterol content of the blood, stimulation of the blood-forming organs, hypertrophy of the uterus, engorgement and bluish discoloration of the female generative tract, incidence of ectopic decidua in the culdesac and luteinized atretic follicles in the ovaries, and enlargement of the mammary gland (Teel).

With increasing knowledge of the relation of the pituitary gland to carbohydrate metabolism certain peculiarities of normal pregnancy have come to be associated with alterations in the function of this gland. That pregnant women are less tolerant of sugar was demonstrated by the writer many years ago. He was able to produce alimentary glycosuria from the third month of pregnancy on, in approximately 80 per cent of his patients, by the oral administration of 100 Gm. of glucose.

The researches of Aschheim and Zondek indicate that an excess of anterior pituitary secretion is excreted by the kidneys in such quantity that the injection into immature mice or into virgin rabbits of small amounts of urine calls forth a characteristic response on the part of the ovaries which can be utilized for the diagnosis of pregnancy. The preponderance of evidence suggests that the hormonic content of the anterior pituitary is partly stored in the chorionic epithelium and its derivatives, which gradually become detached and dissolve in the maternal intervillous spaces, rendering its excretion by the urine possible.

No demonstrable changes occur in the posterior lobe of the hypophysis during the course of normal pregnancy. Very recent obstetrical literature, however, tends to point out hyperfunction of the posterior lobe as an essential etiologic factor in nephropathia and in eclampsia. Küstner and Ehrhardt emphasized the fact that a positive melanophore test may be obtained with serum of eclamptic women. Hoffmann and Anselmino succeeded in showing that both the antidiuretic and the pressor principle are present in the blood in eclampsia and nephropathia. Moreover, the experimental work of Fauvet, and of Dietel, tends to show that repeated administration of pituitary extract to laboratory animals may produce lesions in the liver, the kidney, and the brain similar to those occurring in eclampsia (peripheral necrotic and degenerative changes, associated with hemorrhages and formation of fibrinous thrombi, in the liver; glomerulonephrosis; hemorrhagic changes in the convoluted tubules). These observations, which need further study, tend to bear out a view advanced by the writer several years ago, in his studies on the toxemias of pregnancy. The protagonists of the hypothesis of a pituitary hyperfunction may find further support of their contention in the following recently established experimental facts: In response to intravenous administration of commercial pituitary preparations, there occurs hyperglycemia

cortex during gestation. Mitosis occurs only occasionally in the medulla which enlarges very slightly. In 1913, Stewart and Rogoff demonstrated the remarkable fact that the usual sequelae of removal of the adrenals are absent in pregnant and lactating animals, which remain alive for several weeks. It is possible that the high cholesterol content of the blood in pregnancy may exert some obscure protective influence.

In the light of recent experiments (P. Smith), the hypertrophic and hyperplastic changes in the thyroid and adrenals during pregnancy may reasonably be interpreted as a response to hyperactivity of the anterior lobe of the hypophysis, which has been aptly designated as "the leader of the glandular orchestra."

Accepted views of the function of the adrenal cortex, particularly its relation to virilism in females, make it conceivable that hypertrophy of the adrenal cortex may be accompanied by deepening of the voice, and hirsutism on the cheeks of pregnant women. Pigmentary abnormalities particularly marked along the linea alba, about the breasts or upon the face (cholasma gravidarum) which promptly disappear at the termination of labor are possibly an expression of hyperadrenalism.

We have no reliable evidence that any change in the *pancreas* may be attributed to pregnancy.

Liver.—In modern physiology, the liver is regarded as second to the brain only in multiplicity of functions. Its relation to certain endocrine activities is an interesting detail. Owing to its centric position in the human economy the question of hepatic function during pregnancy arouses our keenest interest. In late years a vast literature has accumulated on this subject, ever since Hofbauer (in 1910) coined the term "liver of pregnancy," which served to designate a certain degree of lability of function in the liver correlated with structural changes in its parenchyma. These changes consist in the disappearance of glycogen from the central portion of the lobuli, passive congestion of the central veins and stagnation of bile in the biliary channels. Not all these changes were claimed to be regular concomitants of pregnancy. In the specimens examined, however, a certain degree of glycogen deprivation was demonstrable in an overwhelming majority of normal cases. At the same time, glycogen deficiency was emphasized as an essential element in the pathology of eclampsia and of pernicious vomiting. The clinical interest of such findings is that they may offer a satisfactory explanation for certain alterations of metabolism in pregnancy. Prominent among these are the high incidence of indicanuria and urobilinuria during the second half of pregnancy; alimentary glycosuria, lowering of the urea content of the blood; a tendency toward the appearance of ketone bodies in the blood and the urine; and finally, an increase of bile acids and also of bilirubin in the blood during the last four to five months of pregnancy, as indicated by a positive indirect van den Bergh test in a large percentage of cases.

The correlation of altered functional activity of the liver with structural changes in the organ during pregnancy has occasioned much controversy during the last decade. At present there is no unanimity of opinion, nor do all agree as to the anatomical findings. Basing their claims on the earlier liver tests, clinicians have now and again expressed some skepticism as to the validity of a low reserved liver function in pregnant women. As an aid in disentangling the confused mass of data now currently available we may

group is represented by cells corresponding to the type of monocytes. When hemorrhage occurs into the parametrium, both groups engulf red blood cells. Under these conditions either well-preserved erythrocytes or their fragments can be seen, lying in most cases within the cytoplasm adjacent to the nucleus. In other places these cells contain particles of brown pigment. When fresh specimens are stained intravitally with neutral red, the majority of these cells exhibit granules which have taken up the dye. Through facile demonstration of this affinity of parametrial cells for neutral red and of their ability to ingest red blood cells, the phagocytic ability of these strains of

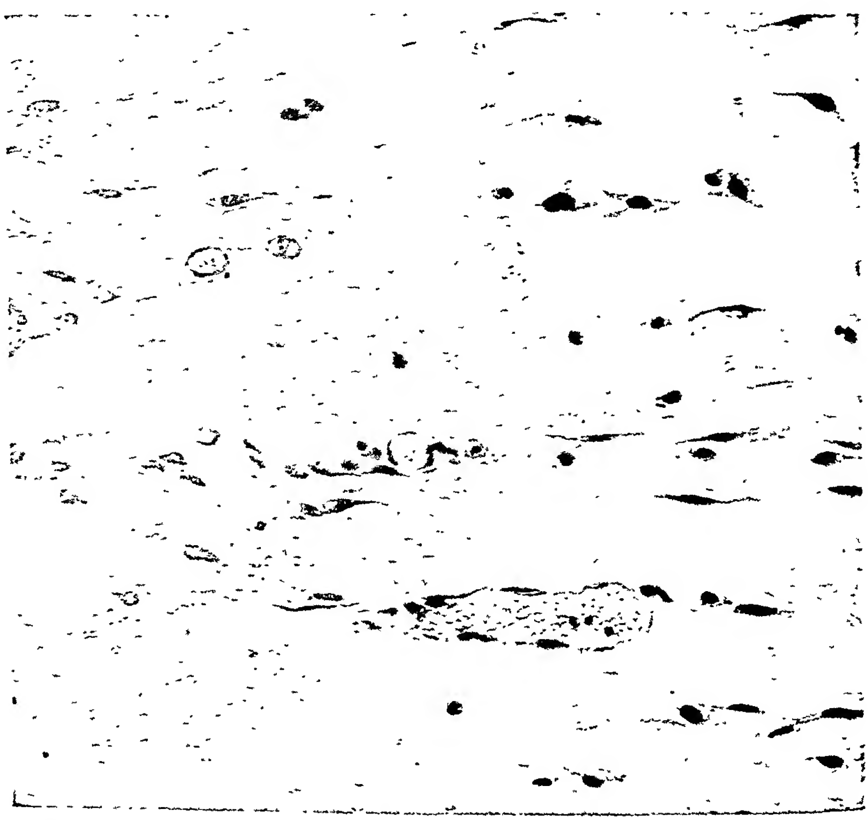

Fig. 310.—Early stage in the development of phagocytic tissue at third month of pregnancy. Note the strandlike arrangement of the cells, and their relation to blood vessels (X 300).

cells may be taken as proved. There is yet another type of cell which invariably constitutes a distinct feature of the cellular strands mentioned. Close proximity to the smaller blood vessels and the presence of coarse granules in the cytoplasm are quite specific for this type of cell, which may be regarded as the original cell of mesenchymal origin from which the clasmatocytes and monocytes are derived.

The cellular reaction of the parametrium during pregnancy and labor can best be understood by describing the variable appearance of this region under different conditions.

that clasmatocytes selectively phagocytose streptococci as compared with polymorphonuclear cells also present. Different areas vary in their resistance to streptococcus infection in accordance with macrophage availability (Gay). In other words, the protective reaction of the parametrial tissue during labor is due to an outpouring of mononuclear cells, which play an important part in localizing the infection by their rôle in the destruction of bacteria and in the development of local immunity. The phenomena above described afford a ready explanation of the fact that many cervical infections, extending beyond the portal of entry, do not become generalized. In con-

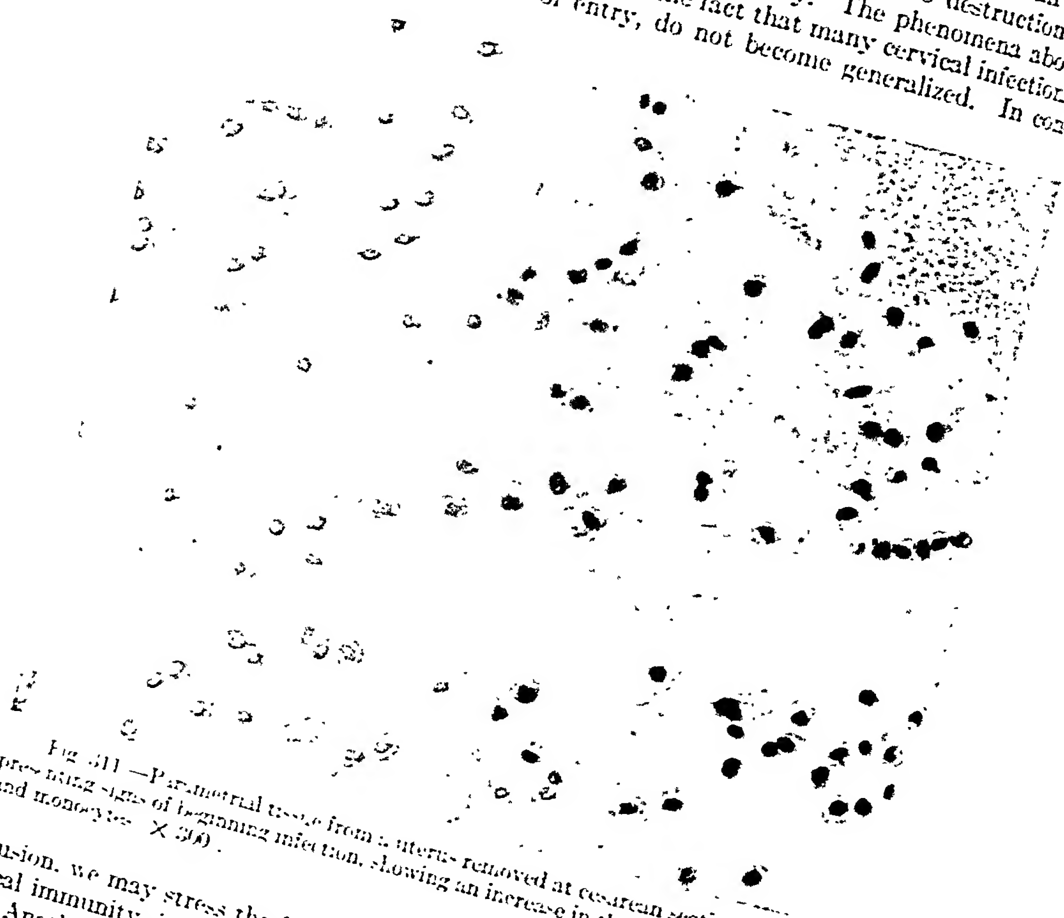

Fig. 311.—Parametrial tissue from a uterus removed at cesarean section from a patient presenting signs of beginning infection, showing an increase in the number of clasmatocytes and monocytes. × 300.

clusion, we may stress the fact that a similar biological response, resulting in local immunity, is demonstrable in the tissues of the lower uterine segment.

Another important feature is the hypertrophy of bundles of unstriated muscle traversing the broad ligament. Neoformation of such structures is most pronounced in the vicinity of the uterine artery. The periarterial sheaths undergo a remarkable hypertrophy and newly formed strands of plain muscle extend from them far out into the parametrium. Since these vessels with their sheaths form an important lateral attachment of the uterus, their hypertrophy may be regarded as a response to the increased burden imposed on them during pregnancy.

With hypertrophy of the muscle fibers is associated a marked development of mesenchymal tissue between the muscle bands, which resembles embryonic connective tissue. By consulting Fig. 314, taken from a uterus in the sixth month of pregnancy, the neoformation of connective tissue, similar to that described above in the ureteral wall, is clearly seen.

It is pertinent to note, in passing, that under the stress of infections of moderate severity this new active mesenchyme develops cells of the type found in the parametrium, thereby giving the uterine wall an increased capacity to react to the invading micro-organisms.

Over and above the development of mesenchymal tissue, we know of a considerable increase in the number of elastic fibers, which form a network about the various muscle bundles and thus add materially to the strength of the uterine wall during pregnancy. These changes, in conjunction with the

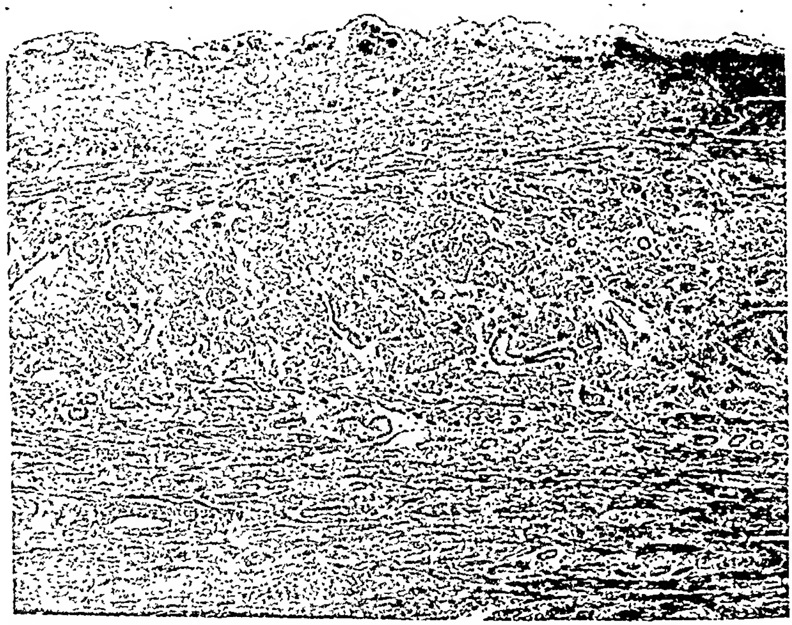

Fig. 313.—Section through outer half of uterus in the middle of pregnancy: A, outermost layer; B, supravascular layer; C, interlacing muscle fibers.

loosening of the connective tissue spaces, fully account for the characteristic doughlike consistency of the walls of the pregnant organ. The remarkable enlargement of the Frankenhauser retrocervical ganglion may be regarded as an expression of the active growth of all the pelvic tissue elements in response to the stimulus of pregnancy. Near term, we witness another interesting, although not perfectly understood biological phenomenon, namely, a considerable increase in sensitiveness of the uterine muscle to pituitary extract.

As the uterus increases in size, it also undergoes important modifications in shape. During the first few weeks, its original pyriform outlines are retained, but the body and fundus soon assume a more globular form, which at the third month becomes almost spherical. After this period, however,

structure under consideration. (For particulars the reader is referred to the author's article in the Jour. of the Amer. Med. Assoc., 1929, vol. 92, p. 540.)

At the fundus, the longitudinal superficial layer covers almost the entire front of the organ but disappears at its sides, where it is connected with the broad ligaments; it is present to a slightly lesser extent on the posterior wall. The development of the longitudinal bundles is most pronounced in the middle third of the anterior uterine wall, all the way from the fundus to beyond the loose attachment of the peritoneum; while on the posterior wall the structure terminates, in most instances, halfway between the fundus and the internal os. On the other hand, on the posterior wall of the lower uterine segment there is a superficial band of longitudinally arranged fibers which spreads bilaterally to a varying extent. Figure 315 illustrates the appearance of the two constituents of the superficial uterine layer under low magnification, the longitudinal band and the circular fibers being separated by broad connective tissue spaces.

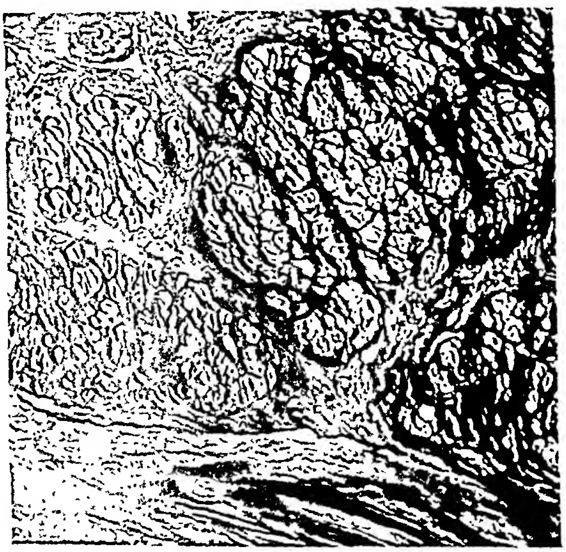

Fig. 315.—Photomicrograph of outermost layer of uterus in the middle of pregnancy; iron hematoxylin (× 140).

The distribution of the specialized system in the outer portion of the pregnant uterus is visible to the naked eye, in hardened specimens, as distinct longitudinal bands arranged mainly in parallel fashion. In transverse and mesial sections through uteri preserved in Kaiserling's solution, the structure appears as a well-defined whitish formation, from 1.5 to 3.5 mm. thick, which occupies the entire peripheral zone from the bladder reflection anteriorly to the middle of the posterior wall. There it ends abruptly, to reappear in the region of the lower uterine segment.

The outermost layer of the uterine musculature is best appreciated at cesarean section. When the uterus contracts downward after the delivery of the child and the placenta, the superficial margins of the incision are seen to retract some millimeters beyond the bulk of the muscular wall. Upon administration of pituitary extract during this procedure a pale band, from

During pregnancy, the *cervix* undergoes radical changes. These consist chiefly in an extensive proliferation of its mucosa, resulting in the formation of a honeycomb-like structure producing tenacious mucus, and secondly in such extensive development of the blood vessels, particularly veins, in its outer walls as to form an almost erectile tissue (Stieve). Remarkable changes both in the character and arrangement of the cervical epithelium have recently been described by the writer. In 8 of 23 specimens examined, there were evidences of epithelial activity, such as reduplications of layers, vacuole formation and some vesicular polymorphism of the nuclei. The beginning of these changes could be traced to the fourth month of pregnancy. A striking feature in these studies is the occurrence of such changes in discrete places while the neighboring epithelium retains its original character. Reference to Fig. 316 illustrates the findings in a specimen obtained from the middle of pregnancy. These changes in the human cervix, during gestation, are interpreted as an indirect metaplasia or heteroplasia, since the replacement of the specific high columnar cervical epithelium by stratified cuboidal elements apparently results from a marked proliferation of indifferent subepithelial cells, which aggregate and form epithelial columns, extending deeply into the connective tissue spaces. The data here recorded indicate that during pregnancy, a phase of activity sometimes occurs in the subepithelial elements of the cervical epithelium, which apparently have retained their primordial character and, under the influence of certain stimuli, may resume their embryonic potentialities. Whether this peculiar response of the cervical epithelium to the stimulus of pregnancy may become a predisposing factor of clinical importance for later cancer development, is still *sub judice*.

Engorgement of the vessels and copious secretion are the most marked changes in the *vagina* during pregnancy. This increased vascularity in gestation accounts for the violet coloration of the vaginal wall, which is most pronounced around the urethra. There is increased vascularity in all pelvic organs as also in the tissues in the perineal region. Stieve found striking changes in the vaginal walls in anticipation of the distention incident to labor. During the course of pregnancy, the mucosa becomes thicker in consequence of an active growth of the connective tissue elements associated with marked hypertrophy of the muscle cells. Because of such hypertrophic changes, the lower portion of the congested anterior vaginal wall protrudes slightly through the vulval opening. Hypertrophy of the papillae of the vaginal mucosa accounts for the roughness of the membrane, which is rendered even more conspicuous by complicating inflammatory processes (vaginitis granularis).

In response to the added strain imposed upon them during pregnancy, there is also hypertrophy of the levator muscles along with the entire muscular structure of the pelvic floor.

As a growth response to the increasing demands of the growing uterus and its contents the *uterine artery* not only elongates but also shows definite structural alterations. These consist of a hyaline subendothelial thickening of the intima accompanied by a splitting and reduplication of the internal elastic lamina. This elastic hyperplastic change is attended by a marked hypertrophy and broadening of the muscular coat. True sclerosis of the uterine artery may result from repeated pregnancies in rapid succession.

From the periphery of the uterine arteries long strandlike muscular

casionally, however, the decidual formation involves large areas on the lower half of the posterior uterine surface and is productive of symmetrical velvet-like denuded areas, recognizable to the naked eye by their dull sheen and roughened surface. This is well exemplified in the accompanying picture (Fig. 317). While such extensive peritoneal involvement is rare, smaller areas of decidual formation on the lowermost part of the posterior aspect of the pregnant uterus, pinkish in color, are found in a large proportion of specimens. Under the microscope the ectopic decidua appears ordinarily arranged in several layers and in structure closely resembles that of the intra-uterine decidua, except that the elements concerned show a greater diversity in shape. The covering mesothelium of the peritoneum is well preserved and never displays any participation in the decidual reaction. Ectopic decidual formation is often associated with certain late toxemias of pregnancy. The marked resemblance between the topographic distribution of ectopic decidua and endometriosis is worthy of note.

Decidual formation occurs approximately in every third *ovary*. Flat pinkish elevations, rarely exceeding a few millimeters in diameter, are seen to project at discrete points of the ovarian surface. They consist of masses of decidual cells beneath the germinal epithelium of the ovaries. Larger groups of such cells here and there evidently represent stigmata produced by previously ruptured follicles.

Persistence of the corpus luteum and maturation of isolated follicles represent the essential findings in the ovary during pregnancy. Another significant feature is the occurrence of numerous atretic follicles with a marked development of lutein cells in the theca folliculi.

Hypertrophy of the mammary acini and engorgement of the vessels are characteristic changes in the *breasts* during pregnancy. The nipples become considerably larger and more deeply pigmented. The areola, surrounding the nipple, broadens and assumes a pigmented appearance. From the hypertrophy of the sebaceous glands in this area come the small roundish elevations known as *Montgomery's glands*. After the first few weeks of pregnancy a thin, gray-yellowish fluid may be expressed by gentle massage from the nipples (colostrum). This contains numerous round corpuscles, representing cast-off epithelial cells of the mammary ducts. Recent investigations have established the presence of vitamins A, B, C in the colostrum.

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4. Is the fetus alive?
5. What position does the fetus take?
6. How large is the fetus?
7. What is the character of the birth canal?
8. Form and size of the pelvis?
9. Condition of the soft parts?
10. Single or multiple pregnancy?
11. Is the position and development of the ovum normal?
12. Are there any extra-uterine or extragenital pathologic processes?

To determine all these points, a systematic obstetrical examination must be carried out. In this chapter, we shall limit ourselves merely to the question of the existence of pregnancy and its duration, and not to such questions as the examination of the bony pelvis and extrapelvic organs.

In considering the various signs and symptoms of pregnancy, it is interesting to group them according to the time at which they appear during gestation. Eufinger outlines them as they appear in the various months of pregnancy, as follows:

"End of first month: Increase in size of uterus, especially in sagittal diameter.

End of second month: Uterus size of goose egg. Uterus asymmetrically enlarged (Piskacek's sign). Change in consistency of uterus (Hegar's sign). Swelling of the breasts. Colostrum. Loosening and cyanosis of posterior wall of vagina and vaginal portion of cervix. Rounding of external os in primiparae.

End of third month: Uterus size of child's head. Hegar's sign more pronounced. (Fig. 318.)

End of fourth month: Fundus of uterus three fingerbreadths above symphysis. Uterine souffle present. Demonstration of fetus and fetal movements.

End of fifth month: Fundus between symphysis and umbilicus. Fetal heart sounds. Funic souffle. Pigmentation of linea alba and nipples. Chloasma. Cyanosis and loosening of external genitalia.

End of sixth month: Fundus at height of umbilicus. Beginning formation of striae.

End of seventh month: Fundus about three fingerbreadths above umbilicus. Demonstration of fetal attitude. Ballottement of the head. Secondary areola.

End of eighth month: Fundus two or three fingerbreadths below xiphoid process.

End of ninth month: Fundus at costal arch. Presenting part in primipara has entered pelvis.

End of tenth month: Fundus two to three fingerbreadths below xiphoid process. In primipara presenting part with greatest diameter is engaged in pelvis. Average abdominal circumference about 100 cm."

As presumptive signs, we point to the cessation of menstruation, changes in the breasts, morning sickness or nausea and vomiting, quickening, discoloration of the mucous membranes, abnormalities in pigmentation, disturbances in urination, diminished tolerance for sugar, changes in the blood serum and urine.

The probable signs of pregnancy are the enlargement of the abdomen,

persistence of a corpus luteum, that is, the development of a corpus luteum cyst. Amenorrhea occurs in association with diseases of the nervous system, such as dementia praecox, epilepsy, and localized cerebral lesions. Suggestion and hypnosis have been known to suppress menstruation. Marked emotion, such as grief, fear, and fright may result in amenorrhea or develop changes in the menstrual cycle." It is well known that a patient who has a fear that she may be pregnant may occasionally have a considerably delayed menstruation.

Changes in the Breasts.—Definite changes in the breasts, according to some authors, are seen as early as the second month, swelling beginning at that time. As a matter of fact, according to some authorities, these changes are noted in young primiparae as early as the second or third week after impregnation. The breasts continue to increase in size during the course of pregnancy. Striae are developed in the skin similar to those seen in the skin of the abdominal wall. The veins also become very much dilated and can be clearly seen in the subcutaneous tissue.

In the region of the areola one finds about a dozen glands of Montgomery. These are modified sebaceous glands. In addition to these, especially noticeable in the periphery, we see true sebaceous and sweat glands. All of these are definitely increased in size during pregnancy. The development of these structures supposedly makes the nipple and the areola more flexible. On palpation, the increased breast tissue may be felt under the skin and sometimes along the fascia of the pectoralis muscle. There is a definite increase in fat tissue and the connective tissue is more edematous.

In the last months of pregnancy the parenchyma is made up of about two dozen lobes, each on which is divided into several lobuli. The terminal vesicles, like the lung alveoli, are the last ramifications of the ducts. In the nipples are found the exit ducts of the gland lobuli, known as the ducti lactiferi, which come out through the tips of the nipples. Just before they reach the ends of the ducts, there are definite dilatations, known as the sinus lactiferi, which act as small storage basins for the milk secretion.

After the first few months of pregnancy, a thin yellowish fluid, colostrum, may be expressed from the nipple. Colostrum consists of a fluid in which are suspended numerous brown bodies, so-called *colostrum corpuscles*, which represent cast-off epithelial cells that have undergone fatty degeneration. The fluid portion is a transudate which consists in great part of serum albumin. Colostrum contains more protein material and salts than normal milk, but the sugar content is about the same. Microscopically, colostrum can be distinguished from milk by the presence of colostrum corpuscles, by the fewer and more irregular fat droplets and occasional rounded bodies considerably smaller than the colostrum corpuscles (Figs. 319 and 320). Some authors, especially Henry, regard these colostrum corpuscles as leukocytes, which wander through the gland structure into the lumen and there act as phagocytes, picking up stagnant milk globules and subsequently returning to the lymphatic system. The function of colostrum was thoroughly discussed several years ago by Lewis and Wells. These investigators think that the euglobin of the colostrum is formed to provide the fetus with this protein, the importance of this being that this protein is associated with the protective antibodies of the blood. They suggest this as the means by which the fetus obtains these protective antibodies.

sometimes have not been noticed at all. This sign is of no great importance unless the movements are detected by the hand of the examining physician.

Jacquemier's Sign.—Jacquemier, in 1836, discovered that the mucosa about the vaginal opening and the lower portion of the anterior vaginal wall frequently takes on a dark bluish or purplish congested appearance. In 1886, Chadwick of Boston emphasized these changes as a valuable presumptive sign of pregnancy. These changes are seen throughout the vagina and also on the cervix, but to a less degree (Plate I).

Pigmentation of the Skin.—In pregnancy one sees a general pigmentation of the skin. Frequently this is most striking on the nipples and the areola, on the abdomen in the midline, and on the external genitalia. Abdominal scars are especially increased in pigment. The linea alba shows a straight line of pigmentation up to the xiphoid process, and the navel shows a deeply pigmented area, which is usually ring shaped. This is sometimes referred to as the *areola umbilicalis*. In certain areas where there is previously existing pigmentation, such as nevi or freckles, these become more characteristically dark. Such areas as the forehead, cheeks, and mouth are occasionally covered with yellowish-brown structures and give the appearance of a mask, to which the term "chloasma gravidarum" is given. The extent of these discolorations varies according to the individual. Dark complexioned women and women who are naturally strongly pigmented show the most marked changes. Sensitivity to the sun's rays also plays a part in this change. In the winter months the pigmentation of pregnancy is supposedly seen to a less degree than in the summer (Plate II).

Changes in Adrenal Glands.—It is interesting to mention in this connection that the adrenal gland undergoes rather striking changes in pregnancy. During pregnancy the cortex of the adrenal gland is markedly enlarged, due chiefly to the increase of the cells of the zona fasciculata, both in size and in fat content. It is suggested that the adrenals have to do with the production of cholesterol, which is well known to increase to a considerable degree in the blood during pregnancy, as does the fat content of the blood as a whole. It is pointed out that in Addison's disease marked pigmentation of the skin takes place and that the various pigmentations of pregnancy may have some relationship to the adrenals. The medulla of the adrenal as well as the entire chromaffin system produces adrenalin. It has not been definitely determined that there is an increase of adrenalin in the blood during pregnancy. Some have claimed this, but their work has not been substantiated. In spite of this, the fact remains that during early pregnancy, there is a spontaneous and sometimes a quite marked glycosuria which can be artificially produced and exaggerated by the injection of adrenalin. Recently, as is well known, several tests for pregnancy on the basis of an existing glycosuria have been carried out.

Abnormal pigmentation may occur with other conditions, such as tumors of the ovary and the functional disturbances of the ovary which occur in the climacteric.

In addition to the pigmentations of the skin, the skin covering the anterior abdominal wall and adjoining portions of the thighs is subjected to marked tension. This results in the formation of depressed areas which are called *striae of pregnancy*. They are supposedly due to the rupture of the elastic fibers of the reticular stratum of the cutis. In the primipara they appear as

rapidly adjusts herself to her new future, even apparently overcoming the fear of death which all women admit they harbor more or less long. DeLee points out that in some instances the expectant mother may even be exalted in the realization that she is accomplishing the supreme purpose of a woman's existence; on the other hand, to many the advent of pregnancy is undesirable or indeed a greater or less tragedy. He further states that some women become obsessed with the dread that they will die before the baby is born; others fear they will lose their beauty and, therefore, their attractiveness to the husband; some worry about having another mouth to feed, or because the child will interfere with their social pleasures; others, of masculine instincts, repudiate the responsibilities of motherhood because they hamper the "will to power." Finally he tells us that deep undercurrents of feeling may be existent—such as antipathy to the family of the husband or to the personality of the husband or his religion; further, a desire not to bring more children into a contentious and chaotic world.

Metabolic Changes.—Marked changes in metabolism take place during pregnancy as well as numerous changes in the blood. Here we shall consider only such alterations as afford a means to diagnose pregnancy and we can especially mention the variations in sugar tolerance, which can be described under three headings: Alimentary glycosuria, phloridzin glycosuria, and adrenalin glycosuria. These are given by Eufinger:

"(a) *Alimentary Glycosuria.*—The liver is primarily concerned in building up and breaking down carbohydrates. It is aided in this work by the glands of internal secretion, especially the pancreas, and also the thyroid, adrenals, and pituitary bodies, as well as the sympathetic nervous system. As a result of the disturbances of some of these organs, the liver can lose its function of storing glycogen. Accordingly, a hyperglycemia may develop, and as a result of this a glycosuria occurs. Blot, in 1856, was the first to find sugar in the urine of healthy pregnant women. This was observed by other investigators who found that it could be easily produced by taking large amounts of carbohydrates in foods—in other words, an alimentary glycosuria resulted. It has been definitely demonstrated that in pregnancy there is a decidedly diminished tolerance for sugar. Frank and Nothman, as well as Neuberger, were able to demonstrate this as early as the first month of pregnancy. Nothman made a positive diagnosis of pregnancy on this basis in 96 per cent of his cases. Studies of blood sugar curves at the same time showed that there is only a slight tendency in a part of them to be above normal values. From this it is established that an alimentary glycosuria exists in early pregnancy, most likely due to a diminished tolerance for sugar in the liver as well as the increased permeability of the kidney for this substance.

"(b) *Phloridzin Glycosuria.*—It has been established that the use of phloridzin outside the pregnant state causes an increased permeability for sugar in the kidney without the presence of hyperglycemia. Kamitzer and Joseph, as well as Zondek, have established that in a pregnant woman a much smaller amount is necessary to produce this reaction. They have selected as the optimal phloridzin dose for pregnant women 0.002 Gm. subcutaneously. This reaction has been shown to remain positive only until the fifth month and after that it becomes negative. This test has been carried out by a large number of investigators and a good many contradictory reports have been given. That this reaction should be more delicate in pregnancy is rather

by the introduction of foreign material lead to more or less pronounced disturbances in the processes of cellular nutrition. The e › erimental study of the phenomena of disposal of foreign material thus introduced reveals a number of facts pointing to the tendency on the part of the cells to elaborate a special mechanism by means of which they are able to protect themselves in a specific manner against the injurious effects of disturbances of their normal nutrition. According to Abderhalden, this 'protective' mechanism, at least in part, consists in the production of specific ferments, which directly attack the foreign material—not only experimentally introduced foreign substances, but also autogenous tissue cells, or their products, not usually present in the blood stream, may cause the appearance in the blood of specific ferments."

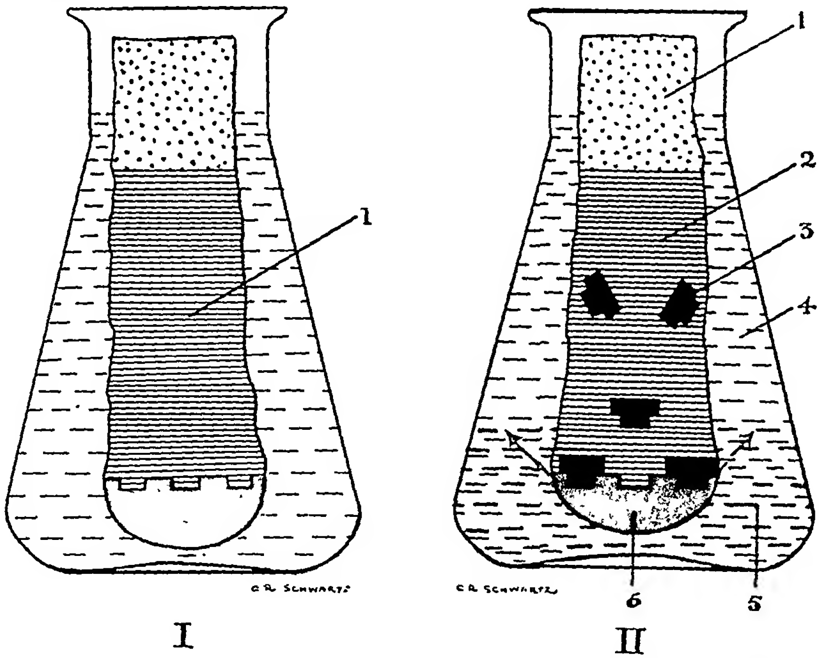


Fig. 322.—Schematic representation of the dialyzing procedure of Abderhalden. I, Serum of a nonpregnant woman. II, Serum of a pregnant woman. 1, Dialyzing thimble; 2, serum of pregnant woman; 3, protective ferments; 4, water; 5, split placental protein; 6, boiled placenta. (After Eufinger.)

The principle of Abderhalden's reaction consists in the detection of the products of hydrolysis when a suspected serum is brought in contact with a specially prepared specific substratum. The procedure most widely used takes advantage of the diffusibility of these products of hydrolysis or digestion. If a serum suspected of containing specific protective ferments is placed in a specially selected dialyzing shell together with tissue (or other substratum) presumably involved, for example, suspected pregnancy serum with a substratum of placental protein, the ferments in the serum react with the substratum and the soluble products of digestion diffuse out of the dialyzing shell into the outer fluid. The presence of protein-split products of digestion in the dialysate by means of a color reaction (the ninhydrin test) indicates the presence of specific ferments in the serum tested (Fig. 322).

Blood is taken from an arm vein and is allowed to stand in a water bath at 15 C. for twelve hours. During this period the clot is well formed and one can readily pour off the clear serum. The serum is now placed in a centrifuge tube and centrifuged until all the remaining red blood cells are sedimented. The color of the serum should now be light to dark yellow. If the blood is taken after a meal the serum appears somewhat clouded as a result of increase in fat content. This has no influence on the reaction, but it is recommended that the blood be taken before meals. Serum that is contaminated with bacteria cannot be used. Also, hemolytic serum is of no value. One cc. of the serum to be examined is placed in a test tube which contains a piece of fresh substratum the size of a pea, or 0.007 Gm. of dried substratum. A known control serum is run as a check against any hemolysis in the serum to be tested. The tubes are now set in an incubator at a temperature of 37 C. for twenty-four hours. On removal from the incubator, 10 cc. of 96 per cent alcohol are added, resulting in a precipitation of high molecular proteins. To complete this precipitation the tubes are heated in a water bath for a short time; the material is then run through a filter which has been previously washed with alcohol. It is perhaps better to centrifuge before filtering. Two tenths to 0.25 cc. of a 15 per cent alcoholic solution of ninhydrin is added to the clear yellow filtrate. The solution is now boiled for one minute and, if the reaction is positive, the solution gives the characteristic violet-blue color.

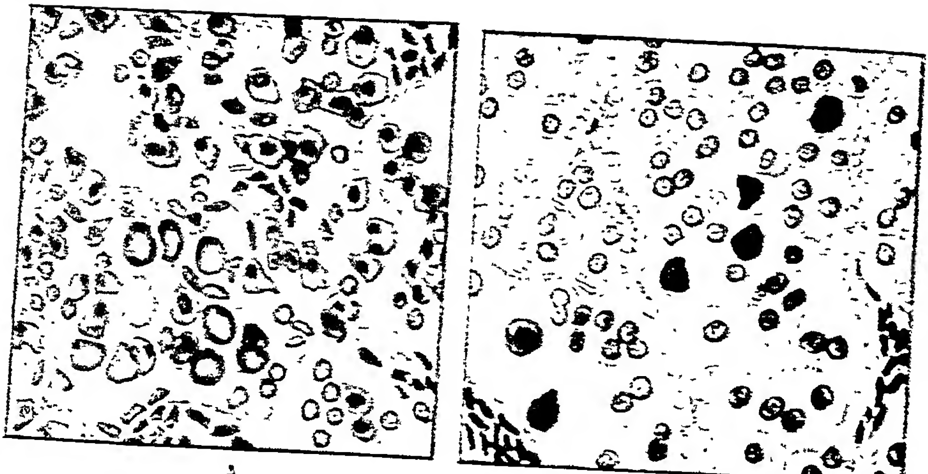
Sellheim, in discussing this method, states that the Abderhalden reaction may only be depended upon in about 78 per cent of the cases, and the Luttge-Mertz reaction gives 98.7 per cent positive results. The improvement, he emphasizes, is entirely due to the preparation of an amino-acid-free substratum. (Sellheim states that the commercial production of this substratum is being carried out by the chemical factory of A. Wolff, Bielefeld, Germany.)

The author has had no experience with this test, but Williams states that as a result of inconclusive reports of others, the procedure will most likely go the same way as many other previously proposed tests.

Linzenmeyer Test.—In pregnancy, the definite increase in the sedimentation of the red blood cells occurs. Linzenmeyer suggested this phenomenon as a diagnosis of pregnancy. This increase in sedimentation time can be definitely determined by the fourth month and occasionally earlier. The reaction, however, is not characteristic of pregnancy alone, but it occurs under other conditions when there is a definite destruction of protein, such as in carcinoma, various fevers, inflammatory processes, tuberculosis, etc.

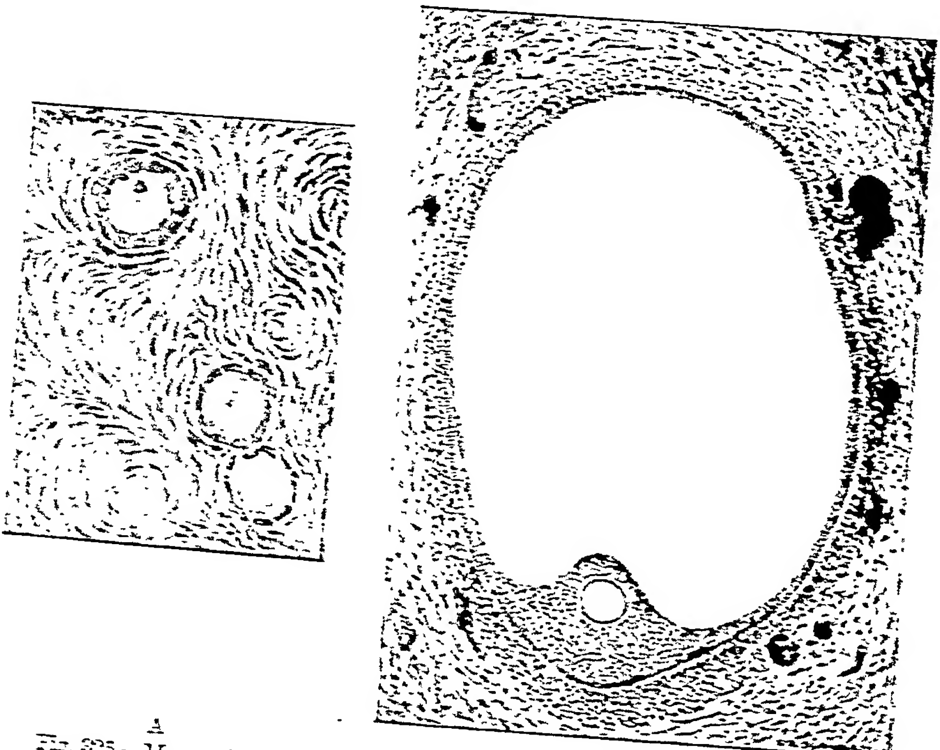
Linzenmeyer suggests that there is a variable differential point between a myoma and a pregnancy, when the pregnancy is supposedly of from four to six months' duration. Fahraeus first emphasized the phenomenon of sedimentation time of the red blood corpuscles while Linzenmeyer was first to consider it as valuable in the diagnosis of pregnancy. Linzenmeyer describes his original technic as follows:

Small tubes were used, which held a little over 1 cm. They were 5 mm. wide and the tube had certain marks. The first one was at 1 cm. From this point they were marked off every 6 mm.—6, 12, and 18. Five per cent sodium citrate was used to keep the blood from coagulating. Two-tenth cc. of this was taken and the syringe was then filled with blood up to the 1-cc. mark. This was then transferred to the graduated tubes. Linzenmeyer found that



A B

Fig. 324.—Anterior lobe of the pituitary gland in the nonpregnant and gravid states. A, Nonpregnant. Note numerous eosinophiles and basophiles, but very few "chief" cells. B, Gravid. Fewer basophiles, very few eosinophiles, but numerous "chief" cells.



A B

Fig. 325.—Maturation of the ovary. The developing follicles of the ovary (A) under stimulation of anterior lobe pituitary hormone (prolan A) develops to the mature stage B. Note the membrana granulosa, discus proligerus, and the liquor folliculi.

zero mark. The tube is placed in a vertical position and allowed to stand undisturbed for one hour, when a reading of the height of the clear plasma

By radiological examination one can find a deepening and a pressure atrophy of the floor of the sella turcica or a widening of the opening. As a result of this enlargement, due to the increase in size and function of the anterior portion of the pituitary gland, changes have occurred which have been described as the "acromegaly" of pregnancy.

According to Williams, it has been suggested that the nonedematous swollen features of the face as well as of the extremities have some relationship to the activity of the pituitary gland during pregnancy. Rokitansky has described the formation of irregularly shaped plaques of porous and newly

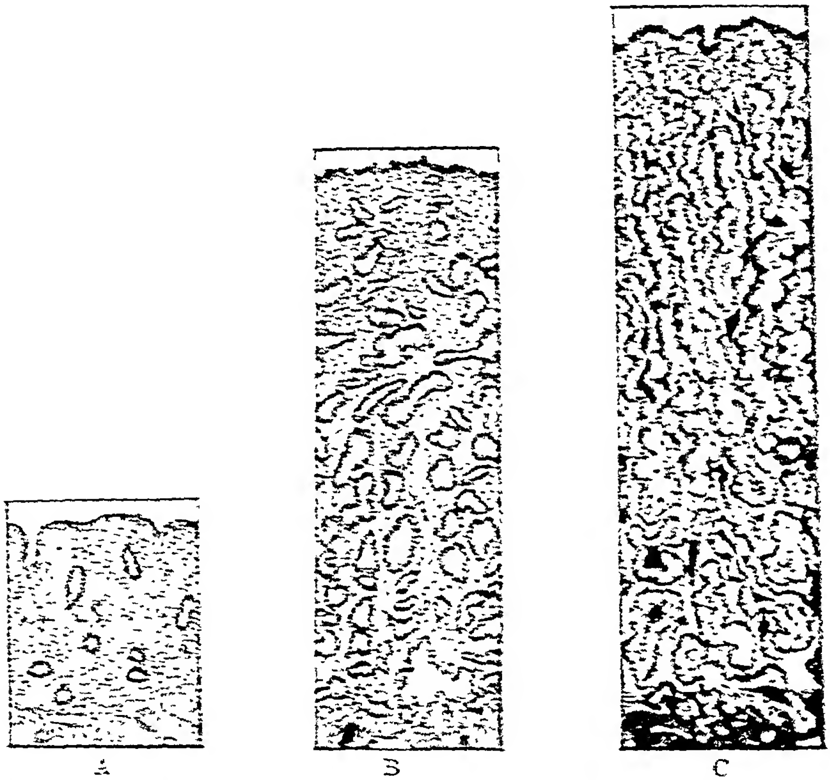


Fig. [illegible].—Development of the endometrium. Under stimulation of the follicular hormone of the ovary, the early interval endometrium "A" is carried to the premenstrual stage "B." Then the corpus luteum hormone together with the follicular hormone is responsible for the development from the early premenstrual stage "B" to the late premenstrual stage "C."

formed bone upon the internal surface of the cranial bones during pregnancy. These aggregations of cells he designated as puerperal osteophytes. Dreyfus states that their existence may be demonstrated by the use of the x-ray, in every third pregnant woman, and is inclined to believe that their production is in some associated with the activity of the pituitary body.

Pressure symptoms have been described upon the optic chiasma and brain, with bitemporal hemianopsia, optic atrophy, cerebral symptoms, and evidence of paralysis on the side of the cerebral nerves involved.

Erdheim and Stumme state that with this enlargement and increase in

Smith and Engel, and Zondek, almost simultaneously, in 1926, reported the effects produced by transplantation of fresh anterior portion of the pituitary gland into infantile mice. Maturity of the test animals was produced in

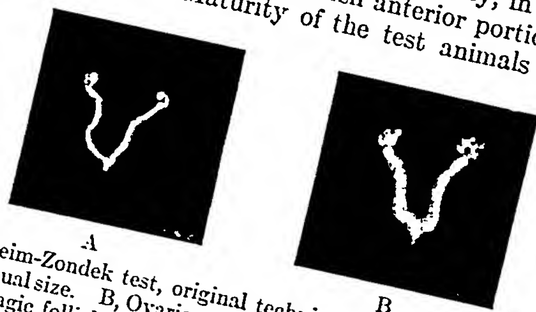


Fig. 328.—Aschheim-Zondek test, original technic. A, Ovaries, oviducts, and uterus of control mouse. Actual size. B, Ovaries, oviducts, and uterus of a "positive" test. Note characteristic hemorrhagic follicles (Blutpunkte). Actual size.

from thirty-six to seventy-two hours at about one half the normal age. Aschheim, in 1927, demonstrated the presence of anterior pituitary hormone in the urine of a patient at five weeks' gestation. This was done by injecting the urine subcutaneously into immature mice with the production of

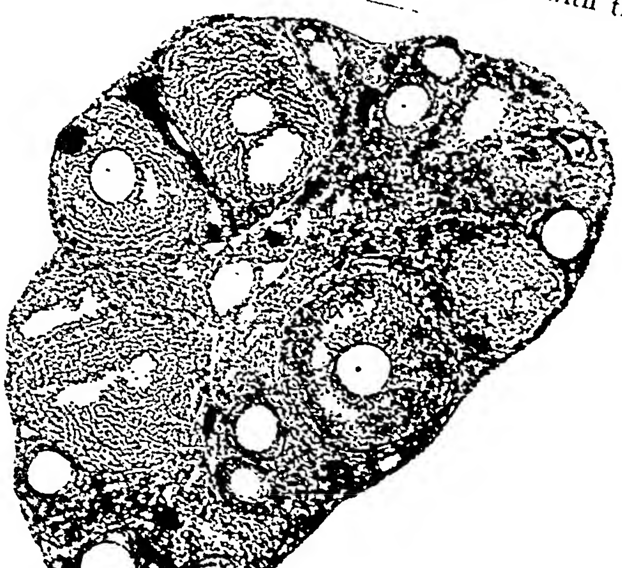


Fig. 329.—Aschheim-Zondek test, original technic. Section of ovary of control mouse. Note only immature follicles.

maturity changes similar to those noted with transplantation of fresh pituitary gland.

In 1928 Aschheim and Zondek offered a preliminary report of the diagnosis of pregnancy by demonstration of the anterior pituitary hormone in

blood serum is sufficient. The use of the rabbit for the test was first suggested by Friedman and later developed by Schneider.

A satisfactory technic for performance of the test with the rabbit as a test animal consists in one injection of 5 to 10 cc. of urine intravenously into a marginal ear vein. After thirty-six to forty-eight hours, the animal is autopsied or inspected at laparotomy. Changes in the ovaries are the same as those noted above with the mouse technic. The rabbit should be a non-mated doe weighing 1500 to 2000 Gm. The urine should be morning voided or catheterized, filtered and weakly acidified with acetic acid if necessary (Plate III and Figs. 331, 332).

Another technic which is very satisfactory in the laboratory of the author also makes use of the rabbit with one intravenous injection of *blood serum*

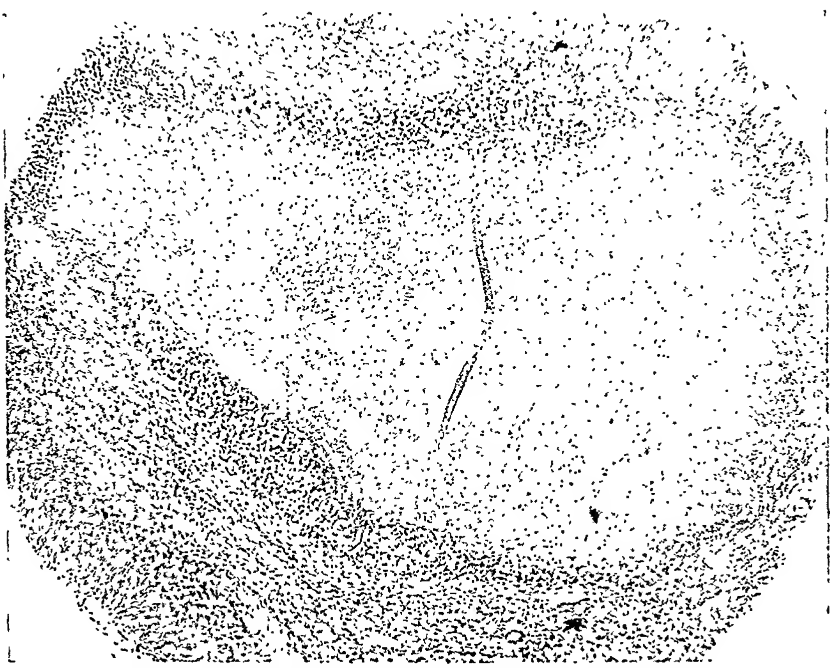


Fig. 331.—Modified Aschheim-Zondek test. Section of rabbit ovary from "positive" test. Low power. Note hemorrhagic follicle with definite border of lutein cells.

instead of urine from the suspected pregnancy. One cc. serum is given for each 600 Gm. weight of rabbit. This procedure eliminates doubt as to the source of the test material and entails injection of a minimal amount of fluid.

With the various technics the results are uniformly satisfactory. Ehrhardt, Liese and Auer, Ammon, Frank, Goldberger and Felshin, Wiesner, and many others who use the mouse technic report, uniformly, 97 to 100 per cent accuracy. Mathieu and McKenzie and Bourg, using the rat as the test animal, arrive at the same degree of exactness. Friedman and Lapham, Beinhart and Scott, Wilson and Corner, Schneider, Brown and Soule report similar results with the rabbit as the test animal.

Enlargement of the Abdomen.—One of the probable signs of pregnancy is the enlargement of the abdomen. The enlargement of the abdomen

early as the sixth week and is definitely pronounced at eight weeks. On bimanual examination, the isthmus of the uterus is compressed between the

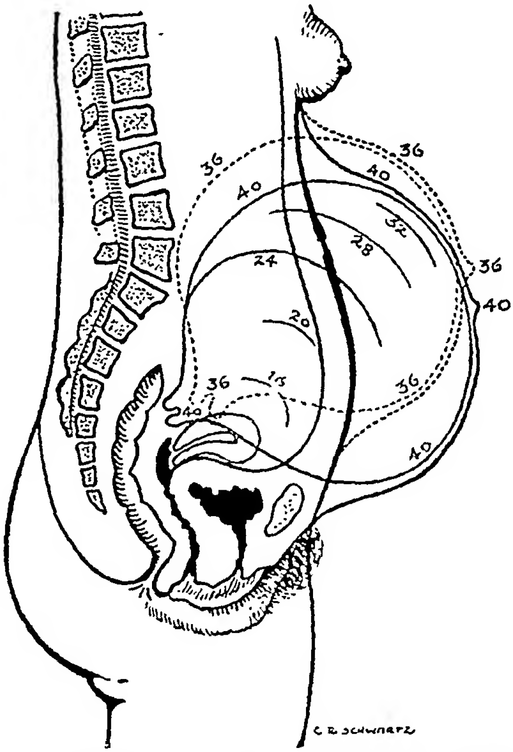


Fig. 333.—Progressive enlargement of uterus and abdomen during pregnancy. (After Eufinger.)

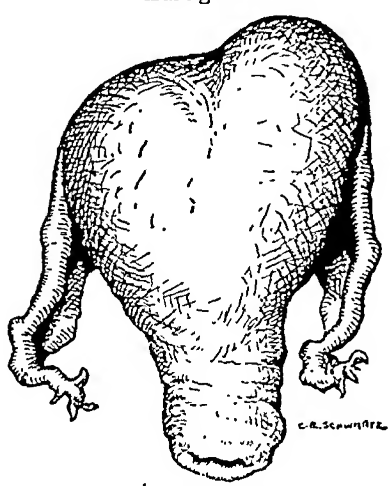


Fig. 334.—Piskacek's sign. Asymmetrical enlargement of the corpus uteri. (After Eufinger.)

fingertips of one hand in the posterior fornix and those of the other hand over the symphysis. By pressing, the fingertips can be practically brought together. The procedure is clearly demonstrated by the illustration (Fig. 318).

shows the comparative heights and sizes of the uterus during various four-week periods.

By the middle of pregnancy, the fetus can be distinctly felt through the uterus and the abdominal wall. By pressing against certain areas, one can

Fig. 338.—Maneuvers of Leopold. First maneuver. Determination of the fetal pole occupying the fundus of the uterus. The breech is large, irregular, and nodular; the head is hard and round, freely movable, and ballottable.

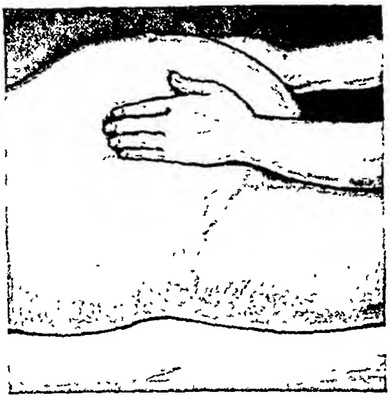


Fig. 339.—Maneuvers of Leopold. Second maneuver. Palpation of either side of the abdomen. The back is felt as a hard, resistant plane. The small parts are felt as numerous nodular masses. Also note whether the back is anterior, transverse, or posterior.

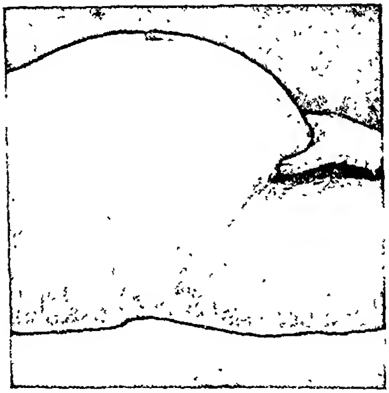


Fig. 340.—Maneuvers of Leopold. Third maneuver. Palpation of the lower part of the abdomen, just above the symphysis. With a wide, firm grasp the presenting part, if not engaged, may be ballotted.

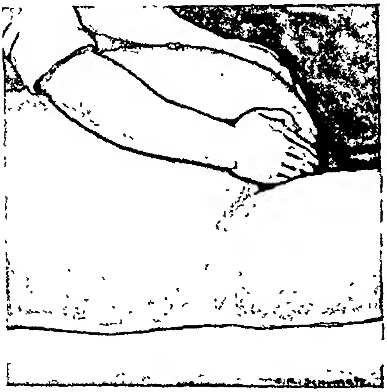


Fig. 341.—Maneuvers of Leopold. Fourth maneuver. Performed only when the presenting part is engaged. Pressure is exerted in the direction of the axis of the superior strait. In vertex presentations, the cephalic prominence arrests one hand while the other descends deeper into the pelvis.

have the part disappear in the amniotic fluid, to promptly return again. This is especially true of the head. This phenomenon is described as ballottement. In making out the fetus it is best to follow a definite plan of examination. For this the four *maneuvers of Leopold* are usually followed. The first three maneuvers are carried out with the examiner facing the pa-

Fetal Movements.—From the fourth month on, one can feel the fetal movements on abdominal palpation. The mother has appreciated these movements usually by the eighteenth week. DeLee quotes Pinard in saying that the skilled observer may determine these movements as early as the twelfth week. These movements can be felt, seen, and heard. In early

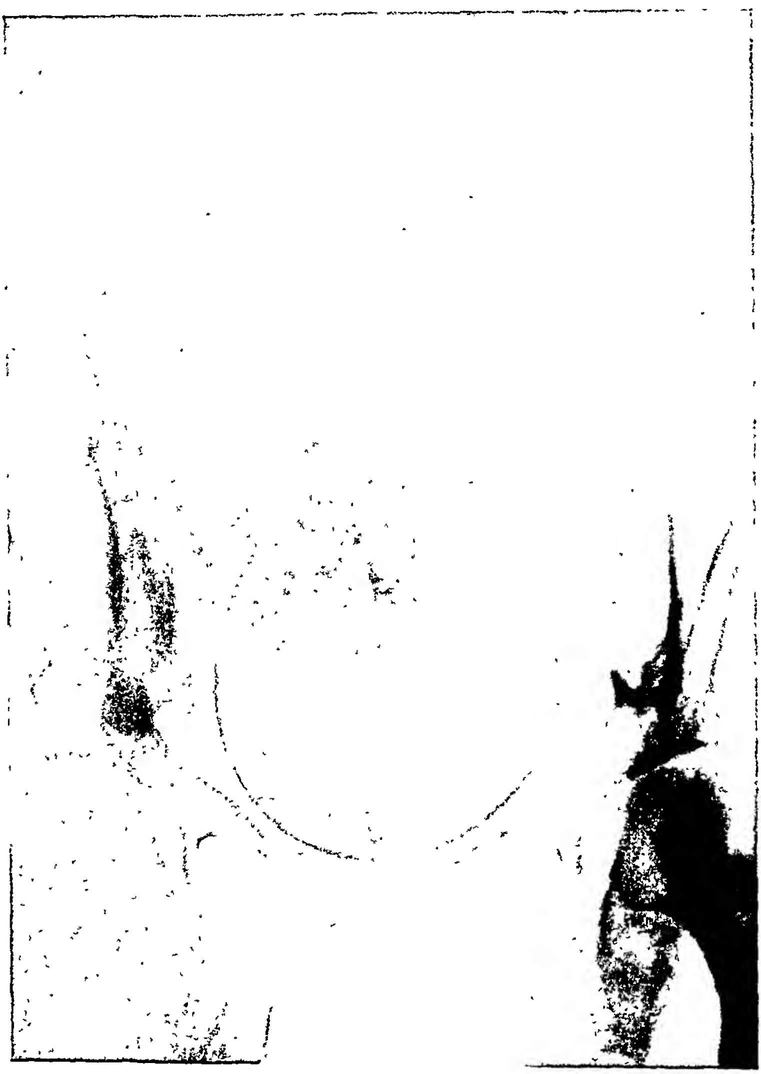


Fig. 343.—Roentgenogram, full-term pregnancy, vertex presentation.

pregnancy they are felt usually as a slight flutter, whereas in late pregnancy they may become quite violent.

Graham, in 1914, was able to increase the fetal movements in pregnant guinea-pigs very remarkably, by ligation of uterine vessels, occlusion of the trachea, and the inhalation of CO_2. This author suggests that the various active movements of the fetus experienced by many pregnant women in the

Part of body.	Primipara.	Multipara.
Abdomen	Swelling long oval.	Swelling half globular in shape often pendulous.
Breasts	Firm, first striae.	Lax, often hanging.
Striae	Reddish in color, smooth surface.	Pale, glistening, often transversely wrinkled.
Abdominal wall	Tight, smooth, only slightly thinned.	Loose, wrinkled and yielding.
External genitalia:		
Vulva	Closed.	Gaping, labia loose, pigmented, often have varicose veins.
Fourchette and perineum	Intact.	More or less stretched, old scars from old tears.
Hymen	Broken ring as a result of primary injury at intercourse.	Appears as series of separated tags due to more extensive injury as result of labor, so-called "carunculae myrtiformes."
Introitus vagina	Dark blue covered area around the urethra.	Anterior and posterior vaginal walls appear more prominently at introitus.
Internal genitalia:		
Vagina	Narrow, folds are firm and crested.	Wide and folds are smooth.
Vaginal portion of cervix	Slightly circumscribed, and crested.	Circumscribed, cylindrical.
External os	Closed, rounded, smooth appearing with mucous plug.	Gaping, transversely widened with the edges often full of small scars, occasionally formation of distinct anterior and posterior lips when lateral lacerations are old enough.
Presenting head	Last month of pregnancy usually as definite segment engaged in pelvis.	Head usually movable about symphysis.

study of the corpus luteum at laparotomy, that ovulation occurred in the intermenstrual period, approximately the eighteenth day after the first day of menstruation. This was confirmed by many investigators, especially Schröder. Most of these gave the physiologic variation as from the fourteenth to the eighteenth day. Robert Meyer considered the period to be from the eighth to the fourteenth, Grosser from the eighth to the ninth. Halban and Koehler felt that it usually takes place from the eleventh to the fifteenth day,

CHAPTER XXI

THE MANAGEMENT OF NORMAL PREGNANCY (PRENATAL CARE)

By William C. Danforth, M. D.
Evanston, Ill.

WITH A SECTION ON VITAMINS IN PREGNANCY

By John A. Urner, M.D.
Minneapolis, Minn.

Nothing in human life is as important to the race as the reproductive function of woman. It is as necessary that she be carried safely through pregnancy as that her labor be properly conducted; and her safety in labor may be influenced, favorably or otherwise, by the care she receives during pregnancy. The observation of the obstetrician should begin early in pregnancy in order that any physical defects may be discovered and, if possible, remedied promptly. As the general physical state of the expectant mother has a direct bearing upon her ability to go safely through pregnancy and labor, the obstetrician should ascertain her condition as accurately as possible, eliciting first a full history of previous illnesses, operations, and labors, following this by a careful examination, both general and obstetrical.

The First Interview with the Expectant Mother.—Especially if the expectant mother is a young woman in her first pregnancy, the obstetrician should strive to put her at her ease and gain her confidence. A few words conveying the impression of a friendly interest will help greatly in dispelling the impression which she may have formed that the visit to the obstetrician is to be a disagreeable ordeal. It is essential that he should have her entire confidence and some effort devoted to obtaining it is well worth while.

History.—Examination should be preceded by a carefully taken history. Inquiry should be made as to infectious diseases, such as scarlet fever and diphtheria. Infections of this sort may have a bearing on the later integrity of the kidneys and circulatory system. Previous attacks of tonsillitis and respiratory infections should be noted. If any operation has been done, particularly in the lower abdomen, as much information as possible should be obtained about it. If the woman has had previous pregnancies, inquiry should be made as to the pregnancies and subsequent labors, as well as to abortions. A history of infection after labor or miscarriage should be noted and any complications which occurred during pregnancy and labor should be gone into carefully. A history of toxemia or any facts suggesting renal trouble during pregnancy is important. It is essential to know whether the pregnancy went to term or terminated prematurely.

Abortions are inquired into: the number, the duration of the pregnancy, whether termination was spontaneous or not, and whether infection followed. If therapeutic abortion has been resorted to one wishes to know the reason for doing it and as much as can be learned concerning its technic and outcome.

PREGNANCY

Mrs. ____ Address ____ Tel. ____

Date ____ Nurse ____ Age ____ Para ____ At Term ____

Prev. Hist. ____

Menst. Hist. ____ Married ____ Yrs. ____

Prev. Preg. ____

Abortions ____

Prev. Labors ____

Puerp. ____

Last Menses ____ Quickening ____ Height ____ Fig. ____

Sp. I ____ Cr. I. ____ Bi. T. ____ D. B. ____ C. D. ____ C. V ____ Circ. ____ Bi. Isch. ____

Date ____ A. S. S. G. ____ Mic. ____ Date ____ A. S. S. G. ____ Mic. ____

Date ____ A. S. S. G. ____ Mic. ____ Date ____ A. S. S. G. ____ Mic. ____

Date ____ A. S. S. G. ____ Mic. ____ Date ____ A. S. S. G. ____ Mic. ____

Obverse.

B. P.

Heart ____

Lungs ____ Thyroid ____

Breasts ____ Nipples ____

Vag. ____

Progress ____

Final Ex. ____

Vag. ____

Reverse.

Fig. 344.—A convenient form of pregnancy record.

serious matter. A routine use of the Wassermann test is better than its employment too infrequently.

The examination of urine includes chemical tests for albumin and sugar and a microscopical examination. It should be remembered that a voided specimen from a woman, particularly if pregnant, will probably contain leukocytes and epithelial cells. If a urinary infection is suspected it is well to secure a catheterized specimen. If albumin is present the amount should

attention at once as it may be accompanied by pelvic deformity. Slight lateral curvatures are noted frequently and in many instances when these are present the pelvis will be found entirely normal. The physician, however, must not take this for granted but must satisfy himself in every case that no pelvic abnormality exists. The characteristic evidences of rickets, the rachitic rosary and alterations in the shape of the head and extremities, should always arrest the attention of the examiner.

If the woman has borne children before, inquiry will be made concerning her previous obstetrical history. A woman of average or more than average size who has delivered infants of normal size without difficulty may fairly be expected to have a normal labor. If a history of a difficult labor is obtained, particularly if the child was of average size, the possibility of pelvic contraction must be considered. The delivery of a small baby at a first labor, however, does not give assurance of later normal labors. It is known that later

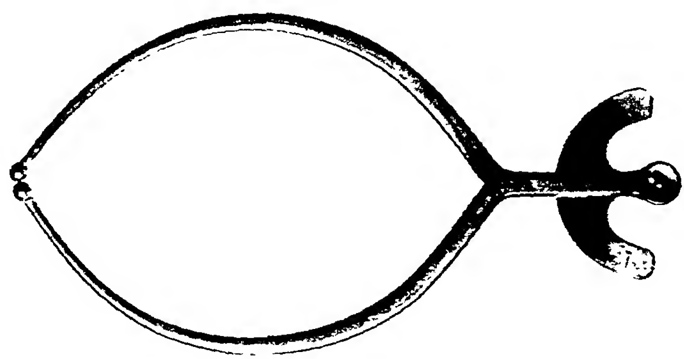


Fig. 345.—Breisky's pelvimeter.

babies tend to increase in size and a second or third labor of such a woman may be difficult.

In primiparae the head of the infant tends to come into the pelvis in the last month. This is not so likely to occur in multiparae. Should the head continue to remain movable above the pelvic inlet as the end of pregnancy approaches, the possibility of disproportion should be seriously considered if the patient is a primipara.

Measurement of Pelvic Inlet.—External Measurements.—These are best taken with the woman upon her back upon an examining table with the hips and lower abdomen exposed. A pelvimeter is required. This is simply a large calipers with the arms sufficiently curved so that, should the pregnancy be far advanced, or the woman be stout, the instrument may encircle the body without touching it. The model devised by Breisky is most satisfactory.

The Distance Between the Anterior Superior Spines, or the Interspinous Diameter.—These bony points are first located with the fingers, the tips of

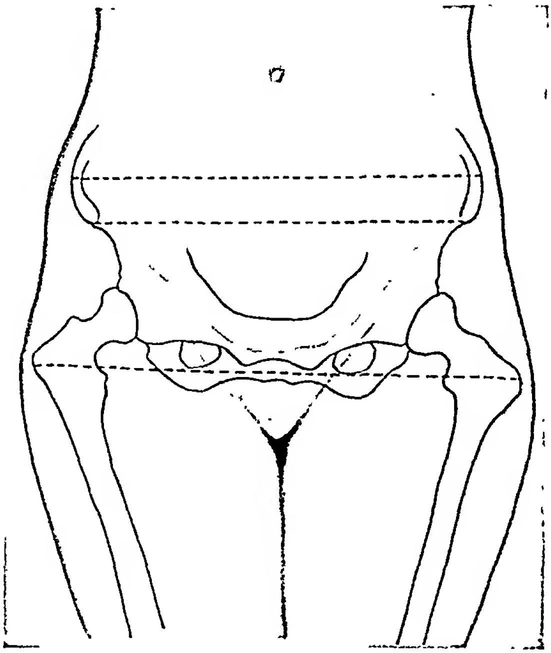


Fig 347.—Relationship of the interspinous, intercristous, and bitrochanteric diameters. (Redrawn from Bumm.)

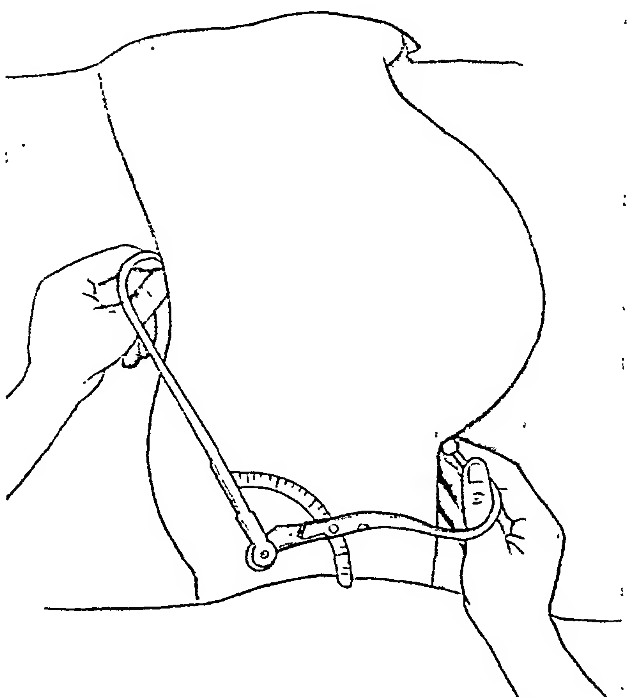


Fig. 348.—Taking the external conjugate. (Redrawn from Williams.)

The promontory is felt by the tip of the middle finger as a projecting bony mass at the upper limit of the sacrum. When the promontory is felt a mark should be made upon the examining hand with the nail of the first finger of the opposite hand. This may easily be done even if a glove is worn on the examining hand. The distance from the mark to the tip of the middle finger is measured and this measurement is the diagonal conjugate. From this the conjugata vera is derived by deducting 1.5 cm. if the pelvis is low or inclined but little and 2 cm. if it is high or markedly inclined. Variations in the configuration of the promontory also influence the length of this diameter. This is an approximate estimate but is sufficiently accurate for practical purposes. As Williams says, if the angle between the diagonal conjugate and the symphysis were exactly known one could obtain the conjugata vera by trigonometry. This, however, is not possible.

The conjugata vera cannot be directly measured in the living woman except by the use of some form of instrument which may be introduced between these two bony surfaces. A number of these have been devised but their use is often painful and in some cases demands the use of an anesthetic. Of the internal pelvimeters which have been devised that of Bilicky-Gauss is probably the best.

Opinions vary as to the accuracy of the results obtained by the use of these devices and they are rarely used by obstetricians in this country. Bumm remarks that the best instrument for internal measurement is still the hand. My own experience is in full agreement with this.

At the time the internal measurement is obtained the examiner also palpates the anterior surface of the sacrum in order to obtain an idea of its curvature. An even symmetric curve is normal. Sharper curves, approaching angulation, suggest rachitic changes. In normal pelves only the last three sacral vertebrae are within reach. If more than this may be felt the probability of contraction is great. The mobility and configuration of the coccyx is ascertained by grasping it between the fingers in the vagina and the thumb outside. It should be mobile and should continue the curve of the sacrum. A sharp anterior angulation suggests an ankylosis following a previous injury. This may produce some obstruction in the second stage of labor.

The transverse diameter of the inlet cannot be directly measured in the living woman by an instrumental method. The *x*-ray method of Thoms may be considered if it appears imperative to obtain it. It may be indirectly done with approximate accuracy by the use of Skutch's pelvimeter. This procedure is complicated, the instrument is rarely available, and the results are only moderately satisfactory.

Measurement of the Pelvic Outlet.—The space between the tuberosities of the ischium may be approximately estimated at the time the pubic arch is inspected.

This space may be measured by carefully palpating with the thumbs until the most prominent portion of the mesial side of the tuberosity is located. The thumbs are then so placed that their nails occupy the plane which would represent the prolongation of this portion of the bone in a direction parallel to the long axis of the body. The distance between the nails is then measured with any pelvimeter. A number of outlet pelvimeters have been devised. That of Thoms is a practical one and may also be used

marks in Doederlein's Handbuch, this is the only measurement which in the living woman is smaller than in the skeleton.

The anteroposterior diameter of the outlet, from the lower border of the symphysis to the tip of the coccyx, may be obtained with any pelvimeter. One arm of the pelvimeter is applied over the lower margin of the symphysis and the other over the tip of the sacrum, after locating it by palpation. A deduction of 1 cm. from the measurement thus obtained gives this diameter with fair accuracy. It is normally 9.5 cm. but may, by the bending backward of the coccyx, if this is normally mobile, be increased to 11.5 cm.

The anteroposterior diameter of the outlet is divided by the line uniting the two tubera ischii into an anterior and a posterior sagittal diameter. Williams properly points out that in those cases in which information concerning the anteroposterior diameter is most desired it is of least use. Should the transverse diameter of the outlet be notably lessened, the pubic arch becomes so narrow that only a small segment of the head may enter it. The possibility of delivery, then, may depend upon the space available between the bi-ischial diameter and the tip of the sacrum or the posterior sagittal diameter. This should be taken when the transverse diameter is less than 8 cm. Discussion of the influence of pelvic abnormality upon labor will be found in another chapter.

Regular Observation during Pregnancy.—It is essential that the expectant mother be seen by the obstetrician often enough throughout pregnancy to enable him to be fully informed as to her condition. A very practical rule for the normal pregnant woman is to visit the obstetrician every three weeks up to the seventh month, every two weeks from then until the beginning of the ninth month, and from the beginning of the ninth month until delivery once a week. Three things should be done at each visit without exception. The blood pressure should be taken, a fresh specimen of urine examined, and the woman's weight observed. In addition to these indispensable items, such questions as the woman may offer may be answered. It is not well to give her the impression that she is being hurried. Often the unimportant matters consume more time than the essential ones. A busy obstetrician must cultivate the art of handling patients expeditiously without at the same time appearing hurried.

Years of experience with private and clinical patients have fully demonstrated to the writer that the occasional statement that women will not come as frequently as this is entirely wrong. Both classes of patients will as a rule come readily if the reason is explained. Even if fear of some complication may make more frequent visits advisable no difficulty is met with. It is the exception for a woman not to cooperate in this particular.

A specimen of fresh urine, collected on the day of the visit, should be brought by the patient. Urine which has stood over night will not do. It is not essential that the first urine passed in the morning be brought and a twenty-four-hour collection is not needed as long as no abnormality appears. About 120 cc. or 4 ounces are needed and should be brought in a clean bottle with the woman's name upon it. It should be examined for albumin and sugar and a microscopical examination for the detection of casts and pus should be made. Cellular elements are increased in number in the urine of pregnant women. Should the suspicion of a urinary infection arise it is well to obtain a catheterized specimen taken with the usual precautions as to

that the women to whom it was given required constant medical supervision lest their nutrition should be dangerously impaired. Obstetricians are aware that women suffering from tuberculosis, heart disease, and severe nausea as a rule have children of normal size.

During the war in Europe it was noted that women whose dietary was impaired by war conditions had babies of normal size. Stoeckel says that under the war ration in Germany the size of babies increased a little.

One fact which was definitely noted in Germany during the war was that toxemia and eclampsia appeared less frequently. This was apparent in a number of clinics. The only striking difference in the mode of life of expectant mothers during war time and of the same women under the conditions of peace was that food was less plentiful and that the women therefore necessarily ate less. Experience of many obstetricians since the war has borne this out. In the experience of the writer, both in active private practice and in the observation of the work of colleagues in a hospital service of considerable size, a limitation in the gain in weight of pregnant women as a result of dietary supervision has been followed by a notable decrease in toxemia and eclampsia. The pregnant woman should be advised to limit the gain in weight during pregnancy to 20, or at most 25 pounds. This is to be accomplished by the control of the amount of food taken. She should be asked to decrease if necessary the amounts of fats, cream, butter, and articles of food containing considerable amounts of these. Ice cream should not be forgotten. Many women are surprised to learn that an ice cream soda contains more calories than a liberal slice of roast beef. Sugar, including candy and chocolate, should be taken in moderation. The diet should consist largely of fruits, both cooked and raw, vegetables, cooked and raw, meat being taken moderately not more than once daily. It is essential that at least a considerable part of the fruits and vegetables taken should be uncooked in order that their vitamin content may be preserved. Milk may be taken in moderation but if the woman is over the average weight for her age and height this should be controlled. About a pint a day is, as a rule, sufficient. Women are frequently advised by older women, and at times by physicians, that large amounts of milk should be taken in order that sufficient calcium may be obtained. It is true that calcium is found in milk in considerable amount but the pregnant woman may obtain her lime supply in part from green leafy vegetables, a liberal amount of which should appear in the pregnant woman's dietary. Sherman believes that the optimal calcium intake for the adult is 0.67 Gm. daily. A liter of cow's milk contains about 1.202 Gm. of calcium. McCollum and Simmonds[9] point out that the average calcium content in the body of the child at birth is 28.3 Gm. The demand for lime for the bones and teeth of the developing child is great. In some cases the addition of calcium to the dietary in the form of calcium carbonate or calcium lactate may be desirable. The gravida should also be urged to take rather liberally those articles containing vitamin C. These are milk, oranges, tomatoes, and lettuce. The taking of milk liberally may cause too great a gain in weight, particularly if a tendency to weight increase exists, but orange juice, tomato juice, and lettuce may be taken freely.

The value of these vitamin-containing articles will be referred to in the section on care of the teeth.

If a woman is quite definitely overweight the gain in weight during preg-

A liberal amount of water should be taken. About eight glasses of liquids a day is ordinarily sufficient but this may be increased in hot weather when perspiration is free.

The question of the use of liquor is frequently met. This is apparently more of a problem in the United States now than before the prohibition era as more young women of the better classes appear to be using intoxicants than was the case before that time and the quality is invariably bad. Abstinence is best, but moderate use may be tolerated, the harm increasing with the amounts taken. The influence of the physician should always be for as complete a restriction as may be accomplished. Patients vary in their amenability to argument on this score.

Smoking comes up for discussion frequently. Again the less the better although many healthy young women go through pregnancy while smoking moderately without perceptible harm. Excessive use of cigarettes should be discouraged. In private practice many young women are seen who smoke far more than is good for them. The physician in most cases can bring about at least a reduction in the use of tobacco.

Exercise.—A pregnant woman should be encouraged to take a moderate amount of gentle exercise in the open air. She may also attend to the lighter forms of household work. Many prospective mothers are young women who must do some or all of the work of their homes. Heavy work, such as scrubbing floors and lifting mattresses, should be given up if possible. Preparation of food may have to be given up if much nausea is present, otherwise it is not harmful. Dusting, bed making, and other light household tasks may be done. These furnish some exercise and serve to keep the mind occupied.

In addition to household duties a certain amount of exercise in the open air is desirable. Of all forms of outdoor exercise walking is best. Each pregnant woman should be told that she should walk as much as she can without undue fatigue and that she should pay no attention to what other women may do. The more strenuous forms of exercise, such as horseback riding, tennis, skating, and swimming should be discontinued. Long automobile trips should not be taken. A good practical rule at this time, when nearly every family has a car, is that the prospective mother may take any journey in an automobile, provided the roads are good, which may be accomplished in an hour. Long journeys are fatiguing, despite all arguments to the contrary. In the summer months many pregnant women are insistent upon such journeys. A clear understanding should be had that the woman and her husband assume responsibility for any miscarriage which may possibly follow. It is also well to explain that a miscarriage occurring while on a journey, perhaps in some locality in which competent medical care is not available, entails the necessity of being cared for wherever she may be and with such resources as may be available. It is true that the risk of miscarriage after automobile journeys is not great but every physician with a large obstetrical experience has seen occasional cases in which a long journey has been followed by abortion. Trauma is not a frequent cause of abortion.

Golf may be permitted if played moderately. The prospective mother should be cautioned not to play strenuously and to stop if she becomes tired. Nine holes are sufficient for the average pregnant woman, although occasionally a very vigorous woman may play much more than this without harm.

and who exhibit a real valvular incompetence of the saphenous vein and those who, because of the overload of venous backflow through the hypogastric veins, show clinical evidence of increased *deep* venous pressure. While the first group is suitable for obliterative treatment, combined if necessary with vein ligation, the second group should not be treated during pregnancy. However, a few months after delivery, if there are residual venous dilatations, injection treatment may be carried out with the indications and precautions which have been described in current literature."

Lower abdominal discomfort or pain is frequently complained of. It is usually a result of weight and pressure caused by the large and heavy uterus. The discomfort may be accompanied by pains radiating down the legs. These are caused by pressure upon the nerve trunks passing through the pelvis. In the early months of pregnancy one must think of the possibility of a tubal pregnancy. Appendicitis and ovarian cyst with a torsion of the pedicle should be considered. The latter is far less common but the writer has seen

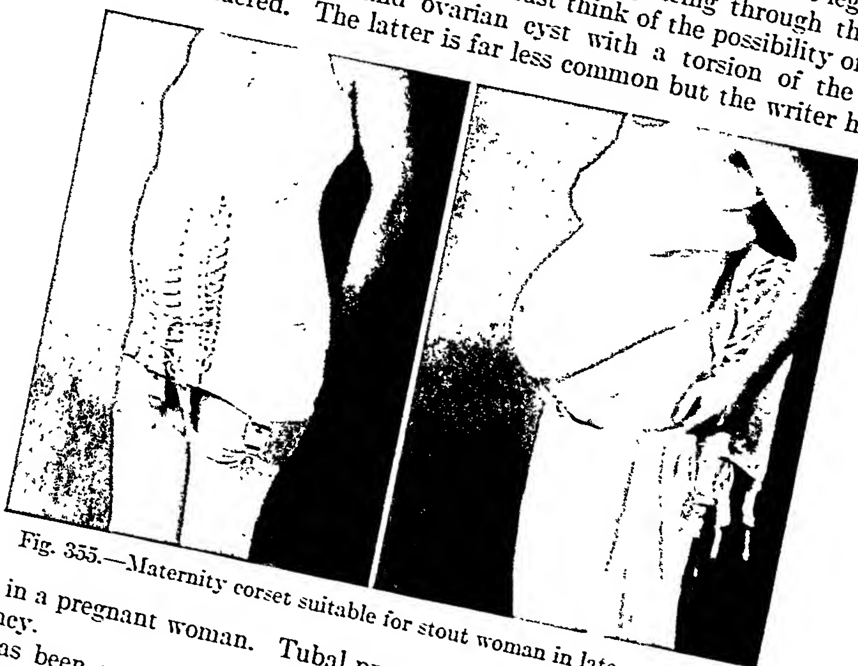


Fig. 355.—Maternity corset suitable for stout woman in late pregnancy.

it once in a pregnant woman. Tubal pregnancy is of less importance later in pregnancy.

It has been suggested that pain may be caused by pressure upon the ureters but it does not seem probable that this is an important cause of discomfort. Recent studies of pyelitis of pregnancy by Hofbauer,[23] Duncan,[15] and Corbus and Danforth[9] all showed the causes of ureteral obstruction to be other than mechanical pressure upon the ureters.

Lower abdominal discomfort is more often felt on the right than on the left side. This is probably due to the fact that the gravid uterus undergoes a dextrotorsion as it rises above the pelvic brim. This is caused by its contact with the surface of the mesentery of the ileum, which rises from the posterior body wall near the median line and extends to the left, producing a broad inclined plane, contact with which deflects the rising uterus to the right. The recumbent position and occasionally a well-fitting abdominal support are the only means of relief.

firmed by others. Leukocyte counts made in 150 consecutive cases of normal pregnancy by Galloway gave an average count of 10,800. A knowledge of these facts is of importance in that, if for any reason a leukocyte count is made for a diagnostic purpose during pregnancy, it should be remembered that a slight leukocytosis is normal.

Until comparatively recently but little attention has been paid to hemoglobin estimation and red cell counts. In most clinics only those women who presented the appearance of a marked anemia have been so studied. The last three or four years have witnessed a considerable display of interest in this matter. Galloway,[20] in his last paper on the subject in 1929, gives a list of forty publications which have appeared in recent years.

In the last 222 women studied by Galloway,[20] 144, or 65 per cent, had hemoglobin readings under 65 Sahli units and red cell counts under 4,000,000. In his total series of 382 cases studied, the average hemoglobin estimations for the first, second, and third trimesters, respectively, were 73, 69, and 66 Sahli units. Average red cell counts for the same women for the same periods were 4,050,000, 3,940,000 and 3,870,000.

First and Goldstein,[19] studying a series of 1000 clinical patients at Jefferson Medical School, found red cell counts of 3,500,000 or less in 47.4 per cent. In this same series only 16.1 per cent of the women had red cell counts of 4,000,000 or over. These observers also found the anemia to be most marked in the third trimester. Their patients showed a hemoglobin of 70 per cent or less in 58.6 per cent, while only 12.9 per cent showed hemoglobin readings of 80 per cent or over.

The results of these two series of studies justify the conclusion that anemia to some degree is common in pregnant women and that it tends to increase as the pregnancy advances.

The anemia should receive treatment, particularly if it is at all marked. Galloway believes that iron and arsenic are of more value than liver, although the latter may be used as well. In a series of 250 patients treated for anemia by means of diet and iron, or iron and arsenic, he found that 74 did not improve. These were then given ultraviolet ray in addition to iron or liver. Fifty-one of them improved satisfactorily.

It may be definitely stated that anemia is frequent in pregnant women. For a discussion of its probable causes the reader is referred to the papers of those who have discussed the subject, particularly Esch, Kuhnel, and Hofbauer. Esch states that a destruction of red cells occurs in the placenta for the purpose of supplying the fetus with the necessary iron for its nutrition and blood formation.

In cases in which the anemia is marked and resistant to treatment a differential count should be made to ensure recognition of a possible pernicious anemia.

Treatment should be instituted. The correction of a pronounced anemia is of distinct value as an anemic woman will withstand hemorrhage less well than a woman whose blood is normal or nearly so. Shock is also more likely to occur in women whose blood is below normal.

Iron and arsenic, liver, or liver extract, and heliotherapy may be used. In summer exposure to the sunlight seems to be of greater value than the use of lamps. When sunlight is not available the violet ray lamp may be used. In either case overexposure should be avoided.

During the early weeks of pregnancy no attention need be paid to the waist bands of the clothing but after the fourth month, and to an increasing degree thereafter, care must be taken as to constriction about the waist. In so far as possible, garments should be made to hang from the shoulders.

The use of circular garters should be advised against. The return circulation from the lower extremities is impeded by the heavy and bulky pregnant uterus and no further unnecessary obstruction should be allowed to occur. It is possible at present to obtain in department stores garter belts which fit about the waist and obtain their support from the hips. These will support the stockings adequately and produce no impediment to circulation.

Shoes are sometimes a problem. Many young women say they are unable to wear anything but the very high-heeled type of shoe. It is probable that in many instances this is true, as long-continued use of shoes of that kind may bring about a permanent shortening of the tendo achillis which may cause discomfort when increased tension is put upon it by the wearing of low-heeled footwear. When possible the pregnant woman should wear a low-heeled shoe which is large enough to give the foot entire comfort. In the later months of pregnancy the prominent abdomen tends to tilt the body forward by its weight and to compensate for this the woman holds her body somewhat back of its usual angle, the so-called "pride of pregnancy." Unduly high heels tend to accentuate this forward tilting of the body and to increase somewhat the difficulty of maintaining balance. Every busy obstetrician is familiar with the frequency with which pregnant women telephone to report falls. A well-fitting shoe, of proper size, is preferable to a very loose or much worn slipper which gives the foot no support.

As pregnancy progresses the problem of abdominal support arises. Many vigorous young women who have not been accustomed to corsets get on very comfortably during pregnancy with no artificial support. Occasionally even these patients, and much more often multiparae whose abdominal musculature is to a greater or less degree relaxed, need some sort of support. If an extreme degree of abdominal relaxation is present, a heavy maternity corset with an additional support for the lower abdomen inside it may be of value. Some makers combine with such a corset a brassiere. These devices are excellent when much support is needed but are rather cumbersome, require time for putting on and taking off, and in hot weather are too warm for comfort.

Many women, for whom these heavier supports are not needed, may receive comfort from a lighter form of abdominal support which holds up the lower abdomen but does not extend above the umbilicus, or but little above that point. Such supports, if made of elastic material in which rubber is incorporated, tend to stretch in a short time. They are best made of a strong nonelastic material. A number of these are on the market.

Care of the Teeth.—"For every child a tooth." In former generations this was probably more than mere fiction. It is known that decay of the teeth progresses more rapidly during pregnancy than at other times and this is particularly true if cavities exist or other defects in the enamel are present.

The first essential is a careful inspection of the teeth by a dentist. The private patient may go to her own dentist or to one suggested by the obstetrician. The clinic patient should have a similar inspection by a dentist attached to the clinic or hospital. No large hospital or clinic should be with-

pressure sufficient to necessitate relief by surgery. Should symptoms caused by pressure be present a thyroidectomy may be done. If definite trouble due to pressure is not present surgery should be deferred.

As Mussey and Plummer have stated, the state of pregnancy demands increased secretion of the thyroid gland. If the gland is normal and the supply of iodine in the body is adequate the increase of thyroid secretion will be sufficient. When these conditions do not obtain disturbance of thyroid function will occur.

That an increase in the basal metabolic rate occurs in the latter part of pregnancy appears to be accepted by most observers. According to Sandiford and Wheeler this is due to the increasing mass of active protoplasmic tissue, consisting in large part of the fetal tissues and in lesser part of maternal structures.

It is known that soon after delivery the metabolic rate falls to approximately that found before pregnancy or in the early weeks of pregnancy.

Mussey, Plummer, and Boothby[32] believe that an increase of the basal metabolic rate to plus 25 or even plus 30 is not necessarily an indication of hyperthyroidism in the latter months of pregnancy.

Plass and Yoakam[36] studied a series of 72 women through pregnancy and for some weeks after labor. They concluded that an "increase occurs during normal uncomplicated pregnancy of approximately 15 per cent and that this falls to normal in the first few days after delivery. A greater rise with slower fall to normal suggests increased thyroid activity incident to pregnancy."

These observers believe that a small proportion of women with thyroid glands which are clinically normal will have a metabolic rate over 20 per cent. Women who have clinically demonstrable thyroid disease are more apt to have high metabolic rates. They interpret this as an evidence that abnormal thyroid glands are less able to respond to the demands of gestation and therefore symptoms of abnormal function appear.

They believe that "iodine given prophylactically during pregnancy is apparently unable uniformly to prevent gestational hypertrophy of the normal thyroid gland, but seems to be quite effective in preventing such a change in glands which are pathologically altered when pregnancy begins, and may actually lead to a reduction in the size of colloid goiters."

C. H. Davis[12] studied the relationship between blood calcium and thyroid function and concluded that no definite relationship could be demonstrated between the two. He also believes that the administration of iodine during pregnancy to a woman with a normal thyroid will maintain her thyroid activity within normal limits, although a slight increase may be seen toward the end of pregnancy.

Physicians who work in regions in which goiter is endemic should be particularly careful that the evidences of thyroid abnormality do not escape attention. The possibility of thyroid disease should be kept in mind in any part of the country. Iodine may be of distinct value in these cases.

In severe and intractable cases of hyperthyroidism during pregnancy, ligation or even thyroidectomy may be necessary. Therapeutic abortion has frequently been done because of hyperthyroidism. The number of therapeutic abortions for this reason should be less in the future. Adequate treatment of the lesser degrees of thyroid disease and the occasional surgical

avoided if possible and the needful bowel activity obtained by vegetables and fruits which will leave a residue in the bowel. In addition to this mineral oil may be used. This functions as a harmless liquid foreign body rather than as the lubricant which it is usually supposed to be. Some of the preparations now obtainable, to which agar has been added, appear to be of greater value than the clear oil. The amount may be varied in different cases. Some women will obtain considerable benefit from a single dose of from 2 teaspoonfuls to a tablespoonful at night while others find it better to use it morning and evening or after each meal. The amount may be varied according to need.

It must be remembered that an adequate amount of water must be taken. When an insufficient quantity of water is drunk, the contents of the lower bowel become dry, claylike masses which are difficult for the bowel to move. Enough water must be taken to supply the normal physiologic needs of the body and, in addition, to cause the contents of the lower bowel to be of a butter-like consistency. If nausea is present, as may be the case in the early weeks of pregnancy, it may be difficult for the expectant mother to take the necessary amount of water, and, indeed, to take the foods which will be of greatest service. In this event cathartics may be needed, but their use should be limited as much as possible.

Should dietary regulation together with the use of mineral oil be insufficient to correct the constipation, it may be relieved by the use of small retention enemas of oil, which should be taken at night. The enema may most simply be given through a small rectal tube or large rubber catheter to which may be attached a funnel about 4 inches wide, which may be obtained from any hardware dealer. The tube is introduced approximately 4 inches into the bowel, and 3 ounces, about one half an ordinary tumbler, of warm oil is allowed to run in. This is permitted to remain until morning when an attempt to move the bowel is made. The enema will often soften hard masses and thus promote evacuation. Should this means of producing regular evacuation need to be repeated several times a cheap grade of salad oil, which is usually cottonseed oil, may be procured from a grocer which will serve the purpose quite as well as the more expensive olive oil of the pharmacist. If this maneuver is combined with the dietary regulation mentioned above the enemas may often be discontinued after a time.

Should colitis be present the collaboration of an internist may be of help. In any event the formation of a cathartic or enema habit should be prevented.

In occasional cases, particularly toward the end of pregnancy, the careful use of cathartics may be needed for a time. The gentler drugs, as phenolphthalein and cascara, may be used; the more drastic ones, such as salines, should be avoided.

Douches.—Vaginal douches should be discontinued in pregnancy, except when indicated by the presence of certain vaginal infections. The treatment of these conditions will be discussed elsewhere.

Any existing leukorrheal discharge may be aggravated by the pelvic congestion incident to pregnancy, and occasionally this may annoy the woman to such a degree that she may insist upon the use of a douche. When this occurs, she should be advised to use a warm—not hot—douche at a low pressure, the douche can or bag being only about 18 inches above the body.

which is so often quoted, is scarcely better than simple guessing and is not advocated.

Mental Hygiene.—"Aequam memento rebus in arduis servare mentem." Nineteen hundred years ago Horace in one of his Odes advised his friend Dellius that in times of stress one should keep an undisturbed mind. A quiet and placid mind is highly important during pregnancy for pregnancy is a time of physical and mental stress for the woman. She should be relieved of all unnecessary domestic burdens. An exacting, unreasonable husband is bad enough at any time but he is a curse during pregnancy. The same may be said of other meddling relatives. Even the mother of the patient may sometimes become a problem.

Some women pass through pregnancy without any mental disturbance. This may be said of the majority of educated women accustomed to the usual measures of self-control. None the less, it should not be forgotten that some women are a little less stable nervously when pregnant than at other times. Those who are about them should try to be particularly considerate during this period.

Some form of mental activity is beneficial. Household duties may help in supplying a useful form of physical and mental occupation. The pregnant woman should not become immersed in a mass of social activities or of club or church work. It is true that some women who are employed, notably in teaching or in clerical office work, may go on until far into the pregnancy without apparent harm. Any work should be given up as soon as fatigue is felt as a result of it. It is better that it should cease soon after the beginning of pregnancy. The society of congenial friends is often helpful. It is unfortunate that young women in their first pregnancies are often disturbed by gruesome tales and other obstetrical misinformation related by older women who are apparently unaware of their own ignorance. It is unfortunate that there is no way of eliminating this sort of person from civilized society. The physician, however, can often be of real use in allaying fears caused in this way, and a few moments given to explanation in the simplest language may give great comfort.

Years of experience impel the writer to question the wisdom of giving pregnant women books which describe the pelvic anatomy and discuss the physiology of pregnancy and labor. It is difficult for them to gain any adequate degree of knowledge, and they are sometimes caused to worry needlessly. It is better that they refer any questions which they may have to the physician who may explain in simple terms as fully as may seem to him to be wise. For the rather rare patient who, notwithstanding the doctor's advice, still insists that she must read something, the best book to recommend is "The Prospective Mother" by J. Morris Slemons or "The Expectant Mother's Handbook" by Frederick C. Irving.

Occasionally women are seen who feel that the reading of good literature or devotion to music during pregnancy will cause the child to become literary or musical. These activities are harmless, indeed may serve to keep the mother's mind occupied, and so may serve a useful purpose. The physician may regard them with an indulgent eye. Conversely, a woman was seen by the writer who was greatly perturbed because, as she believed that conception had occurred while her husband was intoxicated, she feared the child would inherit a taste for liquor. Fears of this sort may be allayed with entire

growths or inflammatory masses and hence is a gynecological rather than an obstetrical procedure. It may be of value in differentiation between intra- and extra-uterine pregnancy. For a complete discussion of the technic and the value of the method the reader is referred to the papers of Reuben Peterson[34] and Cron, and Stein and Arens.[35, 37, 40, 41]

For the recognition of early pregnancy the Aschheim-Zondek test is now rapidly displacing other more complicated and less reliable methods.

For the positive recognition of pregnancy by roentgenography in the later months it is necessary that the fetal skeleton, or at least sufficient of it that it may be recognized as the bony structure of an infant, shall appear in the plate. The earliest centers of ossification may be found in the seventh week in the inferior maxilla and the clavicle and other centers appear in the eighth and ninth weeks. All centers have usually appeared by the end of the third month. The density, however, at this time is scarcely sufficient to make it possible definitely to recognize the fetal skeleton. Horner believes *that it is not possible to use the roentgenogram as a means of positive diagnosis of pregnancy at less than four and a half months.* This is probably true so far as the utilization of the method in average hands is concerned. Those who have become expert in obstetrical roentgenology have been able to demonstrate the presence of a pregnancy earlier than this. Stein and Arens have demonstrated the presence of pregnancy roentgenologically as early as the thirteenth week. In many cases at this time, however, quickening has occurred which would render roentgenography unnecessary. The maternal structures, the uterine wall, and particularly the amniotic fluid interfere with the passage of the rays to such a degree that satisfactory roentgenograms in earlier pregnancy are difficult to obtain. Some successes have, however, been reported. Stein and Arens state that at four and a half to five months they are able to show the whole fetus on the film. In exceptional instances only were these workers able to visualize the fetal skeleton prior to midterm. They give minute directions for obtaining satisfactory results.

2. *To Confirm or Disprove the Presence of Suspected Multiple Pregnancy.*—The *x*-ray is undoubtedly the most satisfactory method of determining the presence of a multiple pregnancy. The presence of two fetal skeletal shadows is conclusive. After the sixth month recognition should be easy. It is usually in the last trimester that the physician becomes suspicious of the presence of a twin pregnancy. Diagnosis by *x*-ray is in many cases rendered somewhat more difficult by the presence of hydramnion, which in some cases of multiple pregnancy may be marked. With the aid of the Potter-Bucky diaphragm one should always be able to show a head after eighteen weeks.

The two heads may not show with equal clearness but one skull shown clearly with two spinal columns is conclusive evidence. In later pregnancies it is usually better to take a postero-anterior and a lateral view. The two films will almost certainly provide enough data for a diagnosis. The *x*-ray is sometimes useful in the differentiation between twins and a hydramnion with a normal fetus.

Triplets may also be recognized by roentgenography although, as G. Veit stated after an analysis of 13,000,000 deliveries in which triplets occurred in the ratio of 1:7910, the necessity does not often arise. The recognition of three fetuses depends on the visualization of three heads or three vertebral

of distinct value in enabling the obstetrician to decide the question of immediate section or a test labor to be followed by section later if necessary.

Deformities may be present, in the study of which a film may be a useful addition to the usual measurements.

5. *The Taking of Pelvic Measurements.*—A number of workers have described methods of arriving at exact pelvic measurements by the use of *x*-ray. In 1896 Albert of Dresden experimented with roentgenological mensuration and was followed in 1897 by Budin and Varnier. Following

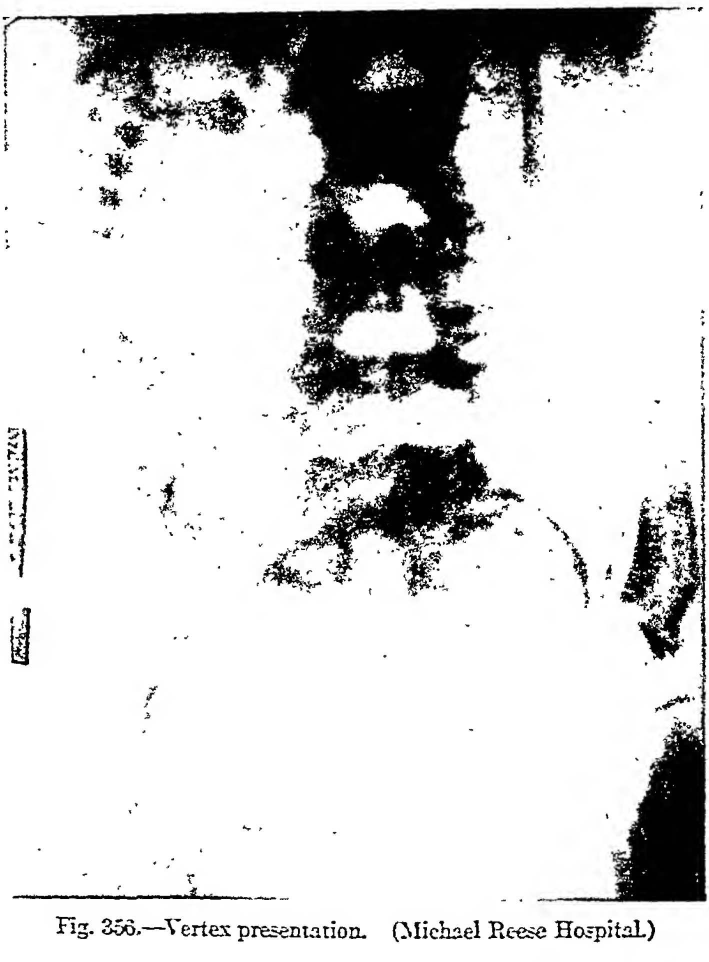


Fig. 356.—Vertex presentation. (Michael Reese Hospital.)

them a number of writers have attempted it. Among the later workers Thoms, Horner, Chamberlin, and Johnson may be mentioned.

Many of the methods described are too complicated for practical use as most of them require more or less mathematical calculation, in some instances of a complicated character. The method of Thoms[12] of Yale is probably the simplest and most practical. He uses a screen composed of squares of lead 1 cm. wide, leaving small intervals between the rows of squares which will appear upon the plate as lines. After taking an exposure of the pelvic inlet upon one film, the screen of small lead squares is placed under the target

7. *To Show Progress during Labor.*—Warenkros of Berlin and Weibel of Vienna almost simultaneously in 1918 demonstrated the mechanism of labor by a series of films and described minutely the process as they observed it. Since then the *x*-ray has been used by a number of workers to demonstrate progress during labor. Its application is limited but it may be used occasionally to determine engagement in a case of relative contraction. Its chief use up to the present time has been as a method of research.

8. *For Diagnosis of Position of the Child When This Cannot Adequately Be Done Otherwise.*—When the position of the child is in doubt, as for example, when the physician believes that palpation suggests the presence of a breech but is not sure, the question may be settled by a film. The same is true of transverse and oblique positions. In this group of cases the roentgenogram is sometimes of real service. The presence of face and brow presentations may be demonstrated upon the film.

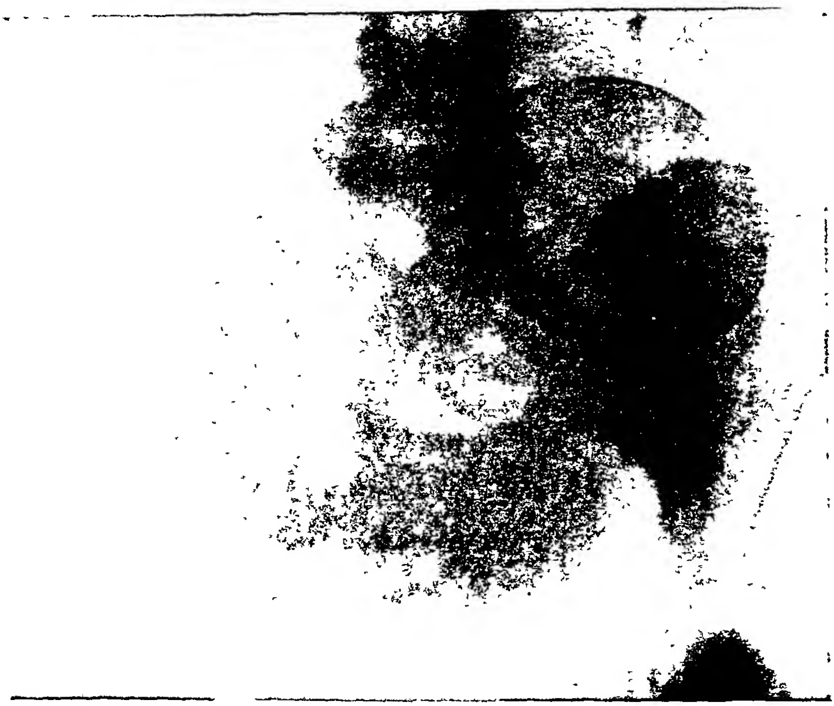


Fig. 358.—Transverse presentation. (Michael Reese Hospital.)

The use of roentgenography before cesarean section is being widely employed. This obviates the exceedingly painful error of performing abdominal section and delivering a monster. It is a procedure which should be highly commended.

Menees, Miller, and Duane[33] report a series of 21 cases in which an opaque solution was injected into the amniotic sac in order to increase the contrast between the fetal structures and the surrounding amniotic fluid by causing the latter to give a denser shadow on the film. They used a solution of strontium iodide, 0.75 Gm. to 1 cc., injecting about 7.5–15 cc. A needle is introduced into the uterine cavity through the abdominal wall, the en-

These statements apply only to the normal woman. If any abnormal condition exists you will be told.

These suggestions should be followed. I cannot be responsible for your well-being if they are not. They apply to every pregnancy whether it is the first or the tenth. All pregnancies are equally important from the standpoint of the care required.

You are asked to read these instructions carefully and often. Do not be influenced by the statements of friends and relatives, which are rarely accurate.

Exercise.—You should get a moderate amount of *recreative* exercise every day, preferably out of doors.

You should spend at least two hours in the open air every day, weather permitting, and you should spend some time out of doors each day regardless of the weather.

The amount of exercise you can take will be determined a great deal by what you have been accustomed to before pregnancy. The principal thing is to avoid exhaustion. One's vitality decreases as pregnancy advances.

Violent exercise such as tennis, riding, and swimming are to be avoided. Golf may be played moderately; nine holes is as a rule sufficient.

Ordinary housework may be done up to the onset of labor. It not only affords proper exercise but keeps one's mind occupied.

Dress.—Your dress should be simple and protective. Avoid overexposure and clothing that does not permit one to meet sudden changes of temperature.

All clothing should if possible be supported from the shoulders after the fourth month.

Avoid overwraps in hot weather such as are used to hide the appearance. They only tax your strength by causing you to become overheated easily.

Use the shoes to which you are accustomed but with no high heels. If your feet enlarge during pregnancy buy larger shoes. Do not wear old or soft-soled shoes or bed-room slippers.

Round garters, or anything which constricts the legs, are not advised. They have a tendency to obstruct circulation, especially that of the veins, and may produce swelling or varicose veins.

General Habits.—One should be quite regular in all habits. A military type of life promotes health in any individual and is strongly advised during pregnancy. You should lie down for an hour after lunch each day. You should avoid irregular eating, social engagements requiring late hours, and responsibilities where haste or considerable energy is necessary. You should not permit your condition to worry you but you should at all times regard yourself as being pregnant and not expect to do the same things that other women are doing.

Diet.—Your habits of eating need be changed very little. Eat the things to which you have been accustomed or the things you like. Taste promotes digestion. Avoid cravings for peculiar types of food, however.

Avoid overeating. One needs no more food than usual. Friends may tell you that you are feeding two and to eat more, but this is seldom necessary. It only tends to throw an added burden on the kidneys and bowel which are already being taxed to capacity. The average pregnant woman gets along very well on from 1200 to 1800 calories a day.

List of Foods and Their Caloric Values

Food.	Average serving.	Calories.
Apple (baked)	1	150
Apple (raw)	1	94
Apple Brown Betty	½ cup	200
Apricots (stewed)	½ cup	100
Asparagus (canned)	5 3″ pieces	19
Asparagus (fresh)	5 3″ pieces	12
Artichoke (large)	1	100
Bacon (med. fat)	3 slices	75
Banana	½	100
Beans, kidney (canned)	½ cup	105
Beans, lima (canned)	½ cup	79
Beans, dried lima (cooked)	½ cup	150
Beans, lima (fresh)	½ cup	56
Beans, navy (boiled)	½ cup	353
Beans, string	½ cup	21
Beans, waxed	½ cup	21
Beef (miscellaneous cuts free from fat)	1 large slice	160
Beef, dried	½ cup	90
Beef, Hamburger steak	1 ball	100
Beef stew	1 cup	300
Beets (fresh)	⅔ cup	47
Blackberries (canned)	⅓ cup	50
Blackberries (fresh)	⅓ cup	30
Boullion	1 cup	24
Bran flakes	¼ cup	25
Bread:		
Baking powder biscuit	2	100
Bran	1 slice	50
French roll	1	100
Graham	1 slice	75
Rye	1 slice	75
White	1 slice	75
Whole wheat	1 slice	75
Broccoli	1 stalk	16
Brussels sprouts	⅔ cup	21
Butter	1 pat	79
Buttermilk	1 glass	70
Cabbage (raw)	⅔ cup	16
Cake, Angel food	1 slice	140
Chocolate	1 slice	200
Fruit	1 slice	200
Plain	1 slice	150
Sponge	1 slice	200
Cantaloupe	1 piece	40
Carrots	⅔ cup	46
Cauliflower	⅔ cup	31
Caviare	1 tbsp.	81
Celery (cooked)	½ cup	15
Celery (raw)	3 pieces	10
Cheese, cottage	2 tbsp.	30
Cheese, full milk	1″ cube	90
Cheese sandwich (toasted)		320
Cheese soufflé	½ cup	100
Cherries (stoned)	½ cup	20
Chicken	2 slices	125
Clams	⅓ cup	50
Cocoa	1 cup	150
Consommé	1 cup	25
Corn	⅓ cup	100

successful use mineral oil, one dessertspoonful or tablespoonful after each meal. Experience will show the amount you need.

During the last month of pregnancy, if constipation exists, a mild cathartic may be needed. Liquid aromatic cascara, one or two teaspoonfuls at bedtime, is often sufficient. This may also be taken in tablet form. A saline cathartic should be used only if needed.

Teeth.—You should have your teeth inspected early in pregnancy by your dentist. They are more apt to decay during pregnancy than at any other time.

The quantity of calcium in one's blood varies between very narrow limits and if your teeth have a tendency to soften and decay you may be benefited by additional calcium in your diet.

Any work that your dentist deems advisable can be done. All cavities should be cared for.

If you are advised to have a tooth removed because of infection it may be and should be extracted regardless of the pregnancy. A local anesthetic is preferable.

Baths.—Warm baths may be taken.

Do not take hot or cold baths. They may have some tendency to cause miscarriage.

Do not sit in the water while bathing during the last three weeks of pregnancy, because there is danger of unsterile water entering the vagina. Nothing should enter the birth canal during that time.

Leg Cramps and Pelvic Pain.—You may be bothered frequently with cramps in the legs or with pains and cramps in the lower abdomen or pelvis. This is especially true in the latter weeks of pregnancy. They are generally due to the pressure of the baby in the pelvis, contractions of the uterus, or softening of the pelvic joints.

A change of position frequently helps. Remove your corset and lie down. The knee-chest position for a short time may help. If the pain occurs in the evening take a walk of four or five blocks and follow with a tepid bath just before you retire.

Backache is generally due to too much physical exertion, faulty posture due to high heels, or lack of proper abdominal support.

Do not confuse these cramps and pains with labor and remember that it is possible for labor to be premature.

Massage also helps many times to relieve leg cramps and backache.

Corset.—If you have never worn a corset you may not need one during pregnancy. This is more apt to be true in first pregnancies than in succeeding ones.

If you have any discomfort due to lack of support or persistent backache you should wear one. They are usually needed about the fifth month.

The corset should be made to order or well fitted. It should be applied while lying down. A corset is not worn to conceal the enlarged abdomen but to support it.

Varicose veins appear frequently for the first time during pregnancy, or may become worse if already present due to the pressure of the pregnant uterus which hinders the venous circulation.

Elastic stockings are of use in certain cases. A few small strips of adhesive may be placed over the veins once a day. That will tend to break up

After Leaving the Hospital.—The return of the uterus to the normal non-pregnant size and weight requires eight weeks at least. Your activities during that time must be with that fact in mind.

If you live in a house remain on one floor until the baby is three weeks old. During the fourth week, until the baby is four weeks old, you may go downstairs once daily.

During the first week at home lie down half of the day. During the second week lie down two hours daily.

At the end of four weeks you may go out, taking short rides and walks which may gradually be increased until at the end of eight weeks you will probably be back to full activity.

You may drive a car at the end of six weeks.

If the uterus tends to assume a backward position the knee-chest position should be taken twice a day for ten minutes each time. You should lie on your face also as often as possible.

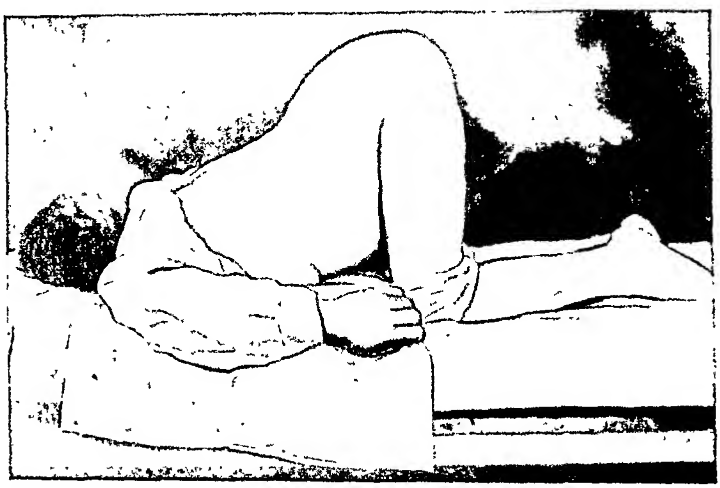


Fig. 359.—Knee-chest position. (DeLee, "Principles of Obstetrics.")

Tub baths may be taken at the end of the third week. Showers may be taken a week earlier.

Report any severe bleeding or any painful lumps in the breasts, particularly if accompanied by fever.

Final examination will be made eight weeks after labor.

Clothing for the Baby.—The following list is taken from "Nursery Guide for Mothers and Nurses" by Dr. L. W. Sauer.

Three to 6 double-breasted undershirts, size 2 (silk and wool for cold, cotton or silk for warm weather).

Three to 6 knitted nightgowns, with draw-string (double weight for cold, single weight for warm weather).

Three slips (cotton or nainsook).

Three petticoats or skirts (flannelette, cotton or linen).

Two dresses, 2 pairs white silk hose.

Twenty-four flannelette diapers (for cold weather).

Forty-eight birdseye cotton diapers (20 x 40 inches).

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for prolonged periods is not advocated because continued compression of the ureteral mucosa may be harmful. Shaw[13] has shown that retention of the ureteral catheter for periods longer than six hours may be followed by damage to the tissues of the ureter with possible later stricture. Lavage of the kidney pelvis through the ureteral catheter has been advocated, the usual antiseptics which have been used being silver nitrate, ½ to 1 per cent, and mercurochrome, 2 to 5 per cent. It is altogether probable that the beneficial effect of the ureteral catheterization is due to the improvement in renal drainage, and only to a minor degree, if at all, to the use of the antiseptic. If the urine is heavily laden with pus the renal pelvis may be gently washed out through the catheter with normal saline solution until the fluid returns clear. This will lessen the danger of obstruction of the catheter. Catheterization of the ureter may be repeated if needed.

Most cases of pyelitis of pregnancy are controllable in this manner. Occasionally, if high fever persists, spontaneous abortion takes place, the fetus having succumbed in utero to the effects of high temperature. If improvement does not follow treatment, and high fever and renal pain persist, therapeutic abortion must be done. With energetic treatment, making use of all possible resources, this is rarely necessary. In case treatment fails, continuation of the septic process may cause serious damage to the kidney and this should not be allowed to take place.

Emptying of the uterus is usually followed by prompt improvement, the obstruction at the vesical end of the ureter being relieved. In the majority of cases it is probable that complete return to normal occurs. Kretschmer[9] believes that the dilatation of the kidney pelvis and of the ureter during pregnancy is only temporary and that it returns to normal after the termination of pregnancy. It is probable that in the majority of cases this is so but evidence exists that, particularly in severe cases, some more permanent changes in the urinary tract may persist. Gardner and Hoerner,[5] in a series of 27 cases of pyelitis of pregnancy studied for periods ranging from four to thirty-three months after pregnancy, found dilatation of the ureter in 8, or 44.4 per cent. Corbus and the author,[1] in a series of 13 cases of serious pyelitis of pregnancy studied for two weeks to four years after pregnancy, were able to demonstrate hydro-ureter and hydronephrosis.

It seems wise to advocate, especially in cases of serious infection of the kidney during pregnancy, that investigation of the urinary tract be carried out after the termination of pregnancy in order that abnormalities in the urinary tract which remain may be recognized and adequately treated.

Details of pyelography and other methods of study of abnormalities at the urinary tract will be considered in Chapter XCVIII. Further information as to their treatment will be found in Chapter XCVII.

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Sure[26] has shown that in vitamin A deficiency there is produced a sterility which he believes is identical with that produced by the absence of vitamin E. The diets used in Sure's experiments contained an abundance of vitamin E. He found that during the stage of resorption of the pregnancies the animals developed a marked ophthalmia.

Vogt[23] has observed that pregnant women on a diet deficient in vitamin A are likely to deliver abnormally developed and dead babies; by feeding cod liver oil and irradiated yeast these disturbances are largely prevented.

All observers (Jackson[18]) have found that vitamin A is essential for the maintenance of the body resistance to infections of all kinds and in its absence every organ or system of the body may become involved in an infectious process. Mellanby and Green[20] have shown that highly concentrated vitamin A used in the treatment of puerperal sepsis has given excellent results. Burton and Balmain[7] concluded from their investigations that there is no prophylactic value in administering vitamin A during pregnancy for the prevention of a subsequent puerperal sepsis. Cramer[8] emphasized the value of vitamin A as a prophylactic agent against infections entering the body through the mucous membranes.

Vitamin B (Complex).—In considering this vitamin it is necessary, because of the older literature, to consider the vitamin B complex, which is composed of a growth-promoting and antineuritic factor, vitamin B, and a growth-promoting and antipellagra factor, vitamin G.

The effect of diets low in vitamin B (complex) has been determined, as regards its effect upon sterility in the male rat, by Funk and Douglas,[12] Allen,[2] Parks and Drummond, and others, who have shown degeneration of the testes in the presence of this deficiency. It is probable, however, that many changes in the male testes were due to a deficiency of vitamin E, as shown by Mattill[19] and Evans.[9] Evans and Bishop[10] have shown that diets low in vitamin B (complex) reduce the vitality of the female rat to the point where ovulation ceases, but that this function will return upon adequate feeding.

Aron and Gralka[3] have shown that vitamin B (complex) is not stored to any extent by the growing organism.

Evans and Burr[11] have shown that vitamin B is essential during lactation and that about five times more is needed than is required in the nonpregnant condition. Sure[26] has demonstrated that at least three times the amount of vitamin B (complex) necessary for growth is required during lactation.

Moore and Brodie[21] have described pyloric obstruction and hemorrhage in the newborn as well as an increased tendency to postpartum hemorrhage in the mother with vitamin B (complex) deficiency.

Jackson,[18] in a review of the recent work on vitamin B (complex), has shown that in its absence from the diet there is atrophy of the ovary or testes and abnormal anatomical changes in the adrenal, thyroid, parathyroid, hypophysis, and thymus glands. Anemia, due to atrophy of the hemopoietic structures, has been found by many observers, though this was somewhat variable.

There has, as yet, been no specific studies made as to the pertinent factors concerning gestation in this deficiency.

Vitamin C.—Ingier[17] found that guinea-pigs placed on a diet deficient in vitamin C in the early stages of pregnancy delivered stillborn young which

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SECTION IV

CHAPTER XXII

PHYSIOLOGY OF THE BIRTH PROCESSES

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LABOR

Definition.—We designate as labor that process by which the product of conception, after attaining maturity or nearly so, is separated from the uterus and expelled into the outside world through the maternal vagina, whether the delivery is spontaneous or demands external aid. When this process occurs after the period of viability (twenty-eighth week, Williams[24]; twenty-sixth week, DeLee[6]) has been reached but before the fetus has attained maturity we use the term *premature labor*. Spontaneous expulsion of the product of conception prior to the period of viability is spoken of, customarily, as *abortion*. For the present we will consider only the process as it occurs at term or very close to term.

Time of Onset.—Labor takes place, usually, about two hundred eighty days after the appearance of the first day of the last menstrual period, at the end of the tenth lunar month of gestation. The onset is characterized by the occurrence of painful uterine contractions, "labor pains," at intervals of fifteen to thirty minutes according to Williams,[24] at intervals of ten to fifteen minutes according to Bumm.[2] Those painless intermittent contractions of the uterine musculature which were present during the entire pregnancy have been replaced now by contractions of greater intensity, causing more or less severe pain, and finally resulting in dilatation of the cervix and delivery of the products of conception, the child and the placenta.

Description of Labor Pains.—Labor pains, aside from their painfulness, exhibit all those peculiarities which are characteristic of the contraction of smooth, nonstriated muscle found in other parts of the body. They are intermittent, they come and go quite independently of any effort and are uninfluenced by the patient's will. The emotions, however, seem to have a very definite effect on the contractions. Sudden shock or excitement may cause cessation of the pains, temporarily, or, on the other hand, may cause an increase in their intensity and frequency. Obstetricians have observed that their entrance into the labor room is frequently followed by temporary cessation of pains.

In the bicornate uteri of the lower animals it has been observed that the uterine contractions are peristaltic in character. Bumm[2] states, however, that, "This process is not observed in the human uterus, due to the fact that these waves of contraction move altogether too rapidly over the entire organ." In the human uterus the contraction begins slowly, rises gradually to reach

may occur during slight movements of the body, after touching the uterus, and, in fact, often appear quite spontaneously. Bumm[9] explains this increasing irritability on the basis of "molecular changes in the protoplasm of the hypertrophied muscle fibers."

2. Some investigators, among them Keiffer,[25] Keilmann,[26] and Knüpffer,[29] have held that the onset of labor was brought about by the gradual formation of the lower uterine segment. The increasing distention of the lower uterine segment is thought to produce a pressure upon the neighboring nerves and upon the cervical ganglion.

3. It is believed by many that during the last weeks of pregnancy certain degenerative processes take place in the decidua which are characterized by deposits of calcium and fat. As a result of these degenerative changes there is a partial separation of the product of conception from the wall of the uterus, thus causing it to act as a foreign body for the time being and giving rise to uterine contractions.

Investigations carried out by Williams[54] show that, under normal conditions, these changes do not occur. It can be demonstrated that, in the later months of pregnancy, those septa which surround the glandular spaces of the spongy layer of the decidua become very thin. Some investigators maintain that these septa rupture frequently during the last weeks of pregnancy and that thus the ovum becomes separated from the wall of the uterus. Others can find no evidence of such rupture, at least, until the third stage of labor.

4. That uterine contractions were stimulated by an excess of carbon dioxide in the blood was demonstrated by Brown-Séquard[8] in 1853. Wigger[53] demonstrated that the presence of carbon dioxide in a concentration of 5 per cent in the inspired air is in many instances followed by exaggerated contractions at the time of labor. Leopold[34] and others have claimed that there is an increased "venosity" (increase in carbon dioxide content) of the placental blood due to the thrombosis of the decidual vessels, and as a result of this there is an irritation of nervous centers.

However true this may be it would be difficult to explain the onset of labor at term on this basis; for, according to Williams,[54] though sometimes such a thrombosis of the decidual cells may be found, it is not customary to find it in the majority of uteri at term. Also, such a thrombosis may occur early in the pregnancy, and still the pregnancy progresses to term. Kehrer[24] maintains that an increase in the carbon dioxide content of the placental blood has no effect on the uterine contractions.

5. There are many who still adhere to the supposition of Galen that the onset of labor is caused by the gradual dilatation of the cervix which, in turn, is caused by the pressure of the presenting part. During the course of routine prenatal examination of patients it can be demonstrated not infrequently, especially in multiparae, that there is some dilatation of the cervix for days and even for as long as two or three weeks prior to the onset of labor. Certainly this theory will not explain the onset in cases of breech or transverse presentation.

6. One of the oldest theories put forth as an explanation of the cause of onset had as its basis an analogy between the uterus and any other hollow viscus found in the body. It has been believed by many investigators that when the uterine distention had progressed to a certain point, the walls of

Fontes,[15] in his studies of the causes of the onset of labor, considered it a complex phenomenon. His experiment in which he injected defibrinated blood into the two horns of a guinea-pig uterus—one with the blood of a woman in the first stage of labor and the second with defibrinated blood of a man—showed an increased amplitude in contraction in the first cornu. He concluded that there was an oxytocic substance in the maternal blood having its origin in the developing ovum and that when its concentration was sufficient uterine contractions were induced.

There has always been some discussion as to the rôle which the central nervous system plays in the onset of labor. Kurdinowsky,[31] Kehrer,[24] and Kruieger and Offergeld[30] have demonstrated that labor may occur and may end spontaneously quite independently of any central nervous system control, central and spinal centers being absent. It has been observed that in patients who have had destructive injuries to the lower portion of the spinal cord the onset and progress of labor is normal and painless.

When it was found that the extract of the posterior lobe of the pituitary gland had oxytocic properties attempts were made to induce abortion or premature labor by injecting the extract into patients. Success was not obtained in inducing abortions but it was found that the extract became more and more efficient the closer to term the injections were made. Knaus,[28] following his experiments with pituitrin on pregnant rabbits, came to the conclusion that in the early months of pregnancy the presence of hormone from the corpus luteum made the uterine musculature refractory to pituitrin. However, he believed that the successful induction of labor in the latter part of pregnancy was due to the fact that the corpus luteum gradually disintegrates and therefore the inhibiting effect of its secretion is no longer present. Here, again, we revert to the "hormonal" theory.

Hofbauer,[21] in 1928, showed in his experiments on excised strips of uterine muscle that sodium glycocholate causes a cessation of contractions which can quickly be restored by pituitrin in the nonpregnant animal. However, as the pregnancy progressed in the pregnant animal, larger quantities of sodium glycocholate are necessary to inhibit contractions and smaller quantities of pituitrin are necessary to restore the contractions. Thus, we see again confirmation of the fact that as pregnancy progresses the uterine musculature becomes sensitized to the action of pituitrin and perhaps to other substances. The problem will probably be solved eventually along these lines.

While we may be able, some time, to explain the cause of labor as due directly to the action of some hormone on the uterine musculature, it is quite possible that some one or more than one of the many causes which have been mentioned above may be an additional factor. There is much research still to be completed on this problem.

Force Exerted by Labor Pains.—Various methods have been used in an effort to determine accurately the force which is exerted by labor pains. It has been estimated to vary anywhere from 577 pounds to as little as 4 pounds. Undoubtedly, there has been gross exaggeration in some of the results obtained, for it has been shown that a force of 120 pounds would tear the child's head from its body.

Kehrer,[24] Schatz,[41] and several other investigators introduced a rubber bag into the uterine cavity, the upper pole of the bag being in close contract

pregnant organ. Synchronous with the first appearance of the tenia in the midline there comes into view an orbicular structure surrounding the insertion of the tubes, as well as a pale zone in the midline of the posterior aspect of the lower uterine segment. These phenomena are most striking when the operation is being performed under spinal anesthesia."

Ivy, Hartman, and Koff[22] were able to study and record for the first time the manner in which the wave of contraction passes over the parturient uterus simplex of the monkey. They found that elliptical, concentric waves of contraction pass medially from a constantly quiescent area slightly ventral and cranial to the insertion of the tubes to meet in the midline and cranial border of the uterus, passing caudally, involving the lower segment and finally the cervix uteri. After the contractions reach the midline they follow the conducting bundle which was described by Hofbauer.[21] The placental site is less involved by the contractions than the remainder of the uterus. They presume that a similar action characterizes the human uterus.

FORCES CONCERNED IN LABOR

The Uterus at the End of Pregnancy.—When term is approached the uterus is found to be divided into two portions; the *corpus* which is a thin-walled, soft, muscular sac varying in thickness from 5 to 7 mm. to which is attached the relatively small *cervix*. The latter seems shorter especially in its anterior portion, which is due both to the normal anteflexion of the uterus as well as to the profound changes which the cervix undergoes during pregnancy. These changes, first clearly demonstrated by Stieve[47] and confirmed by subsequent investigators, consist in a remarkable hypertrophy and proliferation of the cervical mucosa so that it comprises at least one half of the entire structure, converting the greater portion of the cervix into a honeycomb-like organ filled with enormously hypertrophied glands containing mucus. In addition, the hypertrophied muscle fibers are actually decreased in number, the connective tissue becomes more embryonic in type, and the structure outside the canal contains large vessels, especially veins, which give the organ somewhat the character of erectile tissue. The result of these changes is to convert the cervix into a relatively thin-walled structure, 3 to 5 cm. in length, the canal of which is filled with thick mucus. At the lower end is the external os and at the upper the internal os. In primiparae the former is small, barely admitting the tip of the finger, while in multiparae it is patulous, permitting the entrance of the finger up to the internal os.

Formation of the Lower Uterine Segment.—Early in labor the uterus becomes differentiated into two portions: The upper, contractile portion which becomes increasingly thicker and shorter as labor progresses; and the lower uterine segment which is a thin-walled, baglike structure; noncontractile and passive in character. The two are connected by the contraction ring which is easily palpable in labor and which rises higher and higher in the abdomen as labor progresses.

Following the monumental descriptions of Braune[7] and Bandl[3] the origin of the lower uterine segment was for years the subject of serious debate, some investigators claiming that it was derived entirely from the cervix, and others maintaining a dual origin, partly cervical and partly

isthmus undergoes changes in pregnancy similar to those in the body of the uterus, these changes are less pronounced, the canal of the isthmus becoming dilated into a funnel-shaped structure as early as the third month of pregnancy. As term is approached, Stieve[47] has shown that the muscle layer of the lower uterine segment is thinner with the fibers arranged in more or less parallel rows, the compact layer of the decidua contains few blood vessels and the spongy layer is much thinner, with fine glandular septa which are

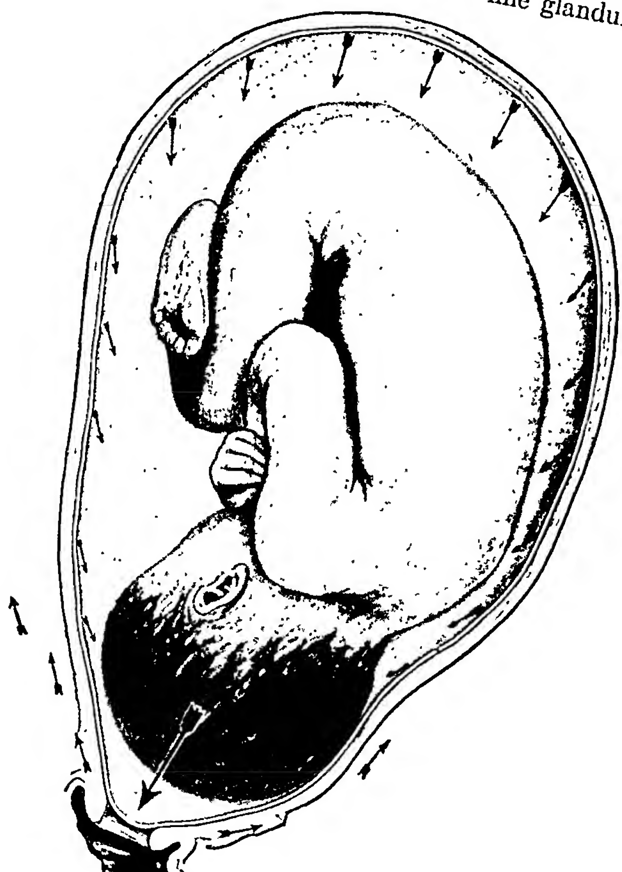

Fig. 361.—Diagram showing action of intra-uterine pressure (DeLee, "Principles of Obstetrics.")

easily torn. With the beginning of labor the fetal membranes in the region of the lower uterine segment are separated from the muscle and take with them most of the decidua. As a result, the membranes become free in this area and are advanced with each pain, while the thinned-out muscle wall expands readily over the advancing membranes.

Dilatation of the Cervix.—As noted above in the discussion of the influence of uterine contractions, the organ early in labor becomes converted into an upper, thick-walled, contractile portion which becomes thicker and thicker

Changes in Fetal Ovoid.—The change in the contour of the fetal ovoid during labor plays no small part in the facility of exit. Schatz[41] and Lars[33] first directed attention to the fact that the contractions of the uterus bring about the dilatation of the cervix through the force exerted equally in all directions on the amniotic fluid but plays no part in the descent of the presenting part. However, when the membranes rupture there is usually not sufficient fluid remaining in the uterus to prevent contact between uterine wall and fetus. Lars[33] showed that in such cases the force is applied directly to the body of the child. The lateral shortening of the uterus causes a straightening out of the vertebral column making it somewhat rigid and permitting the contractions of the fundus to be transmitted through the spine to the presenting part. Olshausen[37] maintains that even in the presence of the normal amount of amniotic fluid such a mechanism is the rule, since more than the normal amount of fluid is required to separate the fundus from the upper pole of the fetus. This view is concurred in by Schroeder,[43] Bumm,[9] Wahl,[49] and others. It has been further reinforced by the *x*-ray studies of Warnekros.[50] The amount of lengthening of the fetal ovoid is estimated by Schroeder[43] to be 5.5 cm., while Olshausen[37] states that it may reach as much as 13 cm.

Changes in the Vagina and Pelvic Floor.—The structures constituting the vagina and pelvic floor undergo profound changes during labor, which consist chiefly in their conversion into a dilated canal of sufficient size to permit the exit of the child. These changes are somewhat facilitated by certain preparatory alterations which occur in pregnancy. Thus, Küstner[32] has shown the marked hypertrophy of the muscles and connective tissue of the pelvic floor and vagina and Stieve[47] has demonstrated the increased vascularity of the parts.

After the rupture of the membranes the changes in the vagina and pelvic floor are brought about chiefly by the dilating effect of the advancing presenting part. As descent proceeds the bladder and adjacent tissues in the anterior part of the pelvis are drawn up behind the symphysis pubis. On the other hand, the levator ani muscle with its superior and inferior fascial coverings, together with the other structures in the posterior pelvis, are forced downward and forward. The vagina is stretched correspondingly so that it loses its rugae and becomes a thin-walled muscular tube, the circumference of which is that of the presenting part of the fetus. The rectum is flattened against the sacrum and levator ani and when the perineal body reaches its maximum of distention the anus gapes widely, revealing the anterior rectal wall.

THIRD STAGE OF LABOR

Separation and Expulsion of the Placenta.—The placenta is normally implanted on either the anterior or posterior wall of the uterus with its lower margin well above the internal os. Following the delivery of the child the uterus contracts downward, obliterating the uterine cavity and reducing the area of placental attachment to such an extent that the placenta becomes much thicker. As a rule, separation of the placenta does not begin until several minutes after the birth of the child, although the investigations of Warnekros[50] and Weibel[51] would indicate that separation is begun earlier than was formerly thought.

Duncan,[15] on the other hand, stated that more frequently separation begins at the placental margin and the structure becomes rolled upon itself in the form of a cylinder with its long axis parallel to that of the uterus. In this mechanism the placenta presents at the outlet by one of its margins and is usually born maternal surface first. Duncan's mechanism is also characterized by slight but continuous bleeding which begins soon after the child is delivered and continues throughout the third stage.

These two mechanisms of placental separation and extrusion were generally accepted until the interesting studies of Warnekros[30] and Weibel[31] appeared in 1918 and 1919. Independently these two investigators injected radio-opaque substances into the placenta through the vessels of the cord immediately after the birth of the child and studied the third stage of labor by means of the *x*-ray. In general, they agreed that separation of the placenta begins within a few moments after the delivery of the child, that the contractions of the uterus and not the retroplacental hematoma brings about the separation, that the placenta invariably leaves the body of the uterus by its margin and that the mechanisms of Schultze and Duncan had only to do with the birth of the placenta and not with its separation. These investigations, while valuable, cannot be entirely accepted because it is well known that the injection of the placental and cord vessels with fluid under pressure alters considerably the normal mechanism of placental separation.

There is much diversity of opinion as to the relative frequency of the two methods of separation. Most of the German authorities state that Schultze's mechanism is the more frequent while by the English authorities Duncan's views are generally accepted. Williams[34] states that the mechanism of Schultze is the more frequent, certainly as regards the actual birth of the placenta, and DeLee[11] is in accord with this view. The frequency of the two mechanisms seems to be considerably influenced by the clinical management of the third stage of labor.

When the placenta and the membranes have been expelled the uterus contracts down into a hard, thick-walled pear-shaped mass, the fundus lying well below the umbilicus. The organ is normally so well contracted that it is pale and anemic, and the ruptured vessels at the placental site are compressed to the point of obliteration of the lumina. This is accomplished by pressure on the vessels as they traverse the interlaced bundles of uterine muscle.

THE CLINICAL COURSE OF LABOR

The actual onset of labor is usually preceded by a period of prodromal signs and symptoms. Descent of the presenting part into the pelvic inlet or "lightening" has usually occurred; in primiparae, three to four weeks before, and in multiparae, from a day or so to a week or more. This change is easily recognized by the patient who is conscious not only that her waist is lower but that the lower abdomen is more pendulous. There is an accompanying relief from upper abdominal pressure and an increase in pelvic discomfort and pressure on the bladder. Abdominal palpation shows that the fundus of the uterus has descended to the position it occupied at the thirty-second week of pregnancy and the presenting part has become fixed in the superior strait. The vaginal secretion has become more marked and is often blood-tinged, the so-called "show." This is due to the dislodgement and expulsion

47. Stieve: Der Halsteil der Menschlichen Gebärmutter, etc., Leipzig, 1927.
———: Ztschr. f. Mikr.-anat. Forschung, 1928, 14, 549.
———: Ztschr. f. Mikr.-anat. Forschung, 1928, 13, 441.
48. Varnier: O'obstetrique journalière, 1900, 174.
49. Wahl: Arch. f. Gyn., 1931, 146, 566.
50. Warnekros: Schwangerschaft und Geburt in Roentgenbilde, München, 1921.
51. Weibel: Arch. f. Gyn., 1919, 111, 413.
52. Wielock: Zentralbl. f. Gynäk., 1927, 129.
53. Wigger: Zentralbl. f. Gynäk., 1928, 2633.
54. Williams: Amer. Jour. Obst., New York, 1900, 41, No. 6.
———: Obstetrics, New York, 6th ed., 1930.
55. Zangemeister: Ztschr. f. Geburtsch u. Gynäk., 1916, 78, 325.

the entire promontory lies anterior to the symphysis and has only soft tissues opposite it. The pelvic contraction ring begins only when the fetus has passed the symphysis and becomes enclosed within the lateral bony walls. For these reasons the true conjugate is in no sense a measure of the pelvic

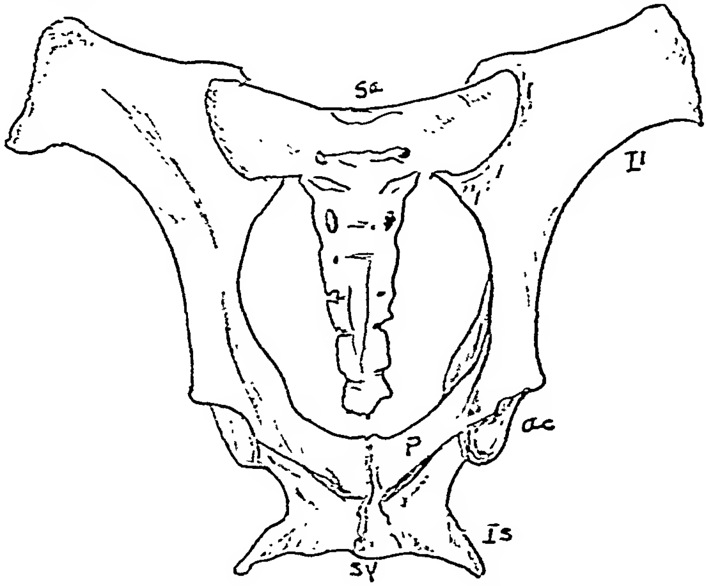

Fig. 372.—Pelvis of one of the larger antelopes (Nilghai). Illustrating the greatly increased obliquity of the true conjugate. Pelvis is drawn as though the animal were in the upright position.

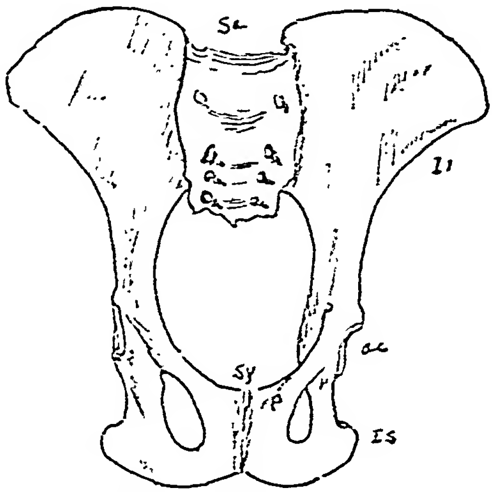

Fig. 373.—Pelvis of the chimpanzee, showing the approach to the human type still with increased obliquity of the true conjugate.

size, since the difficulty in passage lies in the vertical dorsoventral diameter. The form of the pelvic inlet is only of importance so far as it concerns the vertical diameter.

The mechanism of labor in quadrupeds depends upon the form of the pelvis,

Such a passage would oppose no obstacle to the descent of the fetus even at its bony segment, where, by reason of the mechanically perfect fit of the parts, the fetal head would pass unhindered, being opposed only by the elastic muscles and fascia.

In this ideal pelvis the length of the symphysis would be decreased as much as compatible with the factor of safety, the sacrum would be of exactly

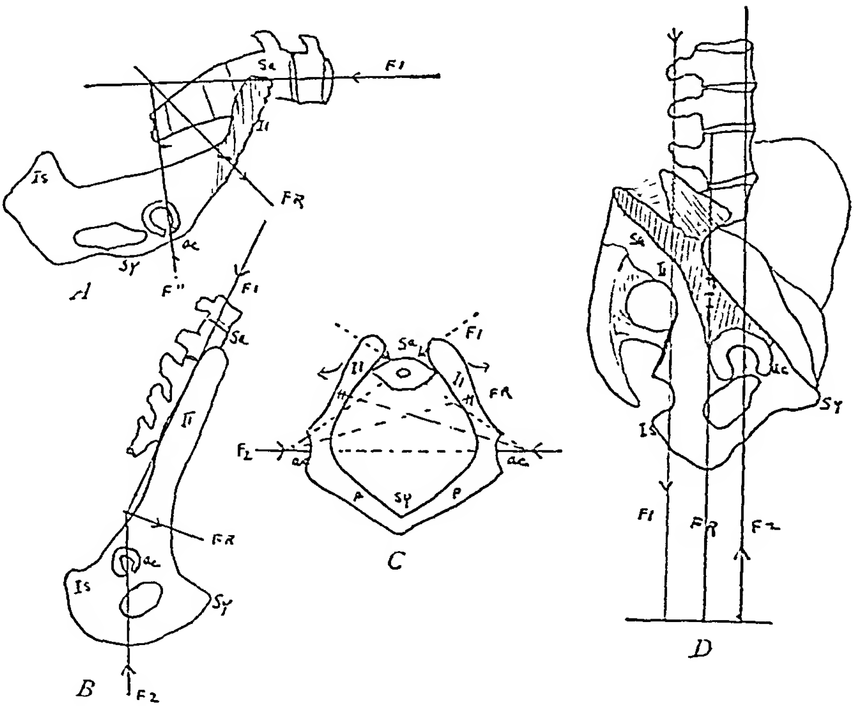

Fig. 374.—*A*, Forces acting upon a quadruped pelvis. F_1, Force along vertebral column and sacrum. F_2, The opposing pressure of the femora upon the pelvis. FR, The resultant of the two forces acting on the long body of the ilium. *B*, The forces acting upon the monkey pelvis. F_1, The push downward and backward upon the sacrum. F_2, The opposing thrust of the femora, FR, the resultant force acting to twist the body of the ilium outward and forward. *C*, A diagrammatic section through the human pelvis at the sacro-iliac articulation. F_1, The force exerted by the posterior sacro-iliac ligament, pulling the posterior margins of the ilia together and forcing the acetabular ends apart, the sacrum acting as a fulcrum. F_2, The force exerted by the push of the femora inward. FR, The resultant of the two forces acting on the weakest portion of the iliac body and tending to curve it outward. *D*, Longitudinal section through the sacro-iliac articulation. (Modified from Owens.) F_1, The weight of the body pushing downward. F_2, The upward thrust of the femora. FR, The resultant of the forces, tending to bend the ilia upward and forward at their weakest portions.

the same length, the promontory would be absent, and the pelvic cavity in its entirety would lie in a plane horizontal to the long axis of the mother and fetus, with possibly a slight slope downward anteriorly. It is noteworthy that the pelvis just described would, by reason of the absence of all inclination, prevent the process of internal rotation. Such rotation is at best a compromise on the part of nature to compensate for the obliquity of the human pelvis, necessary for the maintenance of the upright position, and in itself is

The explanation of the marked preponderance of vertex presentation is quite simple. The fetal head articulates with the spinal column at the occipital condyles, which lie on the posterior aspect of the skull, about two thirds of the head being anterior to this articulation as against one third lying posterior to it. If the head be in the usual "military" position with respect to the trunk, it is obvious that when uterine contractions begin to exert their force upon the fetal trunk, this force is transmitted to the head, which is thrust downward into the pelvic brim. As soon as the head meets with resistance of the bony pelvis and the soft parts lining the inlet, it begins to flex, since the anterior end, being much the longer end of the lever, yields to the pressure sooner than does the short posterior end of the same lever arm. As a consequence, complete flexion occurs fairly rapidly and the head passes the pelvic inlet with the chin in contact with the chest, the vertex first (Fig. 375).

In order that the head may traverse the pelvis without undue difficulty, it is absolutely necessary that flexion be maintained. If the fetal head be scrutinized (Fig. 376) it is seen that the smallest diameter from above downward is the suboccipitobregmatic of 9.5 cm. If now, the head be in complete flexion (Figs. 377–380) it presents an almost circular outline of 9.5 cm. diameter for passage through the bony pelvis. Only in complete flexion is this ideal presentation possible.

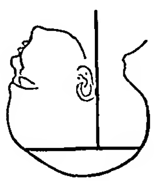

Fig. 375.—Diagram illustrating the cause of the frequency of vertex presentations. (Hirst, "Text-book of Obstetrics.")

The level of the birth canal where flexion occurs varies greatly. In primiparae, where the head early meets the resistance of the tense lower uterine segment and the undilated cervix, the movement occurs early, and is synchronous with engagement. When the pelvis is roomy, the soft parts relaxed, and where no disproportion exists, as in many multiparae, the head may descend well into the pelvis in practically the "military" position, flexion only taking place when the resistance of the pelvic floor is encountered. On the other hand, in contracted pelves where considerable disproportion exists, exaggerated flexion may take place before the head can enter the pelvic brim.

The fetal back lies anteriorly by reason of another manifestation of the law of accommodation. The maternal lumbar spine presents its convex inner surface toward the uterus and the flexed fetal spine is even more convex on its outer aspect. Naturally, two convex surfaces have but a small point of contact, so that the fetal back slips laterally to the maternal spine, and tends to slide forward, permitting the fully movable limbs to adapt themselves to the forward bulge of the maternal spine.

With the mother in the erect position and moving about, the fetal back naturally tends to occupy the roomy anterior position of the uterine cavity, especially if the abdominal walls be slightly relaxed.

and second, the thrusting forward of the rectum and sigmoid into the pelvic cavity, which tends to decrease the left oblique diameter of the brim and also to push the left side of the uterus forward, carrying with it the fetal back and head. The position of the back is, of course, that of the head, there being normally no unequal tension of the neck muscles, so that the occiput most usually enters the pelvis anteriorly and to the left, O.L.A.


Fig. 377.


Fig. 378.


Fig. 379.


Fig. 380.

Figs. 377–380.—Showing difference in attitude of fetus in vertex, sinciput, brow and face presentations. (Williams, "Obstetrics," D. Appleton and Co., Publishers.)

If the resistance of the bony pelvis be taken into consideration, it would at first appear that the descending head should enter the brim in the wide transverse diameter of this portion of the pelvis, but a glance at the diagram (Figs. 381, 382) will make it clear that the greater width of the transverse diameter of the brim is present in but a narrow space just anterior to the sacrum, the inward curving rami of the pubes and ischiae sharply decreasing

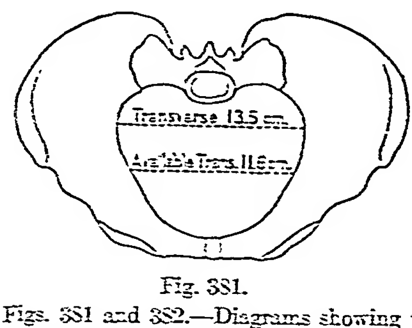

Fig. 381.

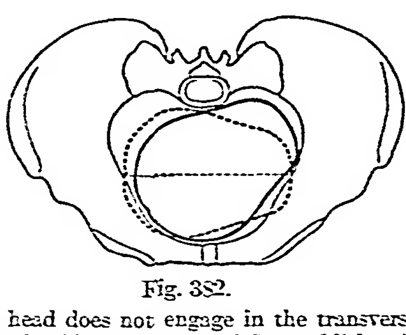
Fig. 382.

Figs. 381 and 382.—Diagrams showing why the head does not engage in the transverse diameter of the superior strait. (Williams, "Obstetrics," D. Appleton and Co., Publishers.)

the width of the brim in its anterior aspect. Therefore, for practical purposes, the available transverse diameter is one which bisects the conjugata vera and is on the average about 11 cm., *i. e.*, a centimeter shorter than the oblique diameter, which latter is a more perfect oval and into which the head will naturally descend when impelled by the uterine contractions.

The steps in the progress of the mechanism of labor in a vertex presentation are as follows:

The reason for this variation is not quite clear, but it is probably due to the greater tonicity of the abdominal muscles in primiparae, as well as to the greater frequency and intensity of the painless uterine contractions of Braxton-Hicks, during the later months of a first pregnancy. After engagement has taken place, the fetal head lies deeply imbedded in the pelvic inlet, the head *fairly straight on the shoulders, with the sagittal suture lying almost midway* between symphysis pubis and sacral promontory. In such position the head is said to be in *synclitism* or *synclitic*. In multiparae especially, where the abdominal muscles are relaxed and the belly is pendulous, the uterus and its contained fetus fall forward, the sagittal suture approaches the sacral prom-

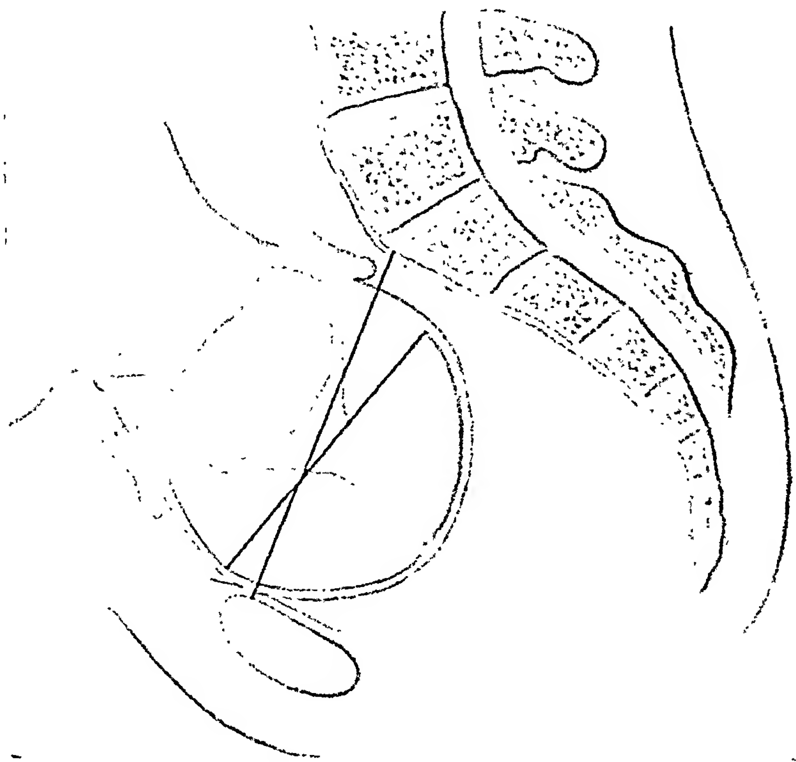

Fig. 384.—The head engaging. Beginning lateral flexion of the head on the body. The anterior parietal bone impinging upon the symphysis. Beginning anterior asynclitism.

ontory and the parallelism between the occipitofrontal diameter of the head and the plane of the pelvic brim is lost. Under these circumstances the anterior parietal bone presents at the pelvic inlet rather than the vertex, and the head is said to be in *anterior asynclitism*. This observation is credited to Naegele, whence the term "Naegele's obliquity." In primiparae, and women with firm abdominal walls, the uterus is pressed closely to the spinal column, and under these conditions the sagittal suture may present anterior to the midline of the pelvis, closer to the symphysis, so that the posterior parietal bone enters the pelvic inlet first (Figs. 383–386). This is known as *posterior asynclitism*. Certain writers believe that asynclitism of one form or the

other is the usual position in which the head enters the pelvis, but it is probable that any marked disturbance of the relation of the sagittal suture to the middle line of the pelvic brim is pathologic. The pelvic cavity has been described as a curved cylinder (Figs. 387–389), the posterior concavity (the anterior wall of the sacrum) measuring 12 cm. in length and the anterior concavity (the posterior aspect of the symphysis) measuring 5 cm. It is obvious that if all parts of a body passing through the pelvis are to reach the outlet at the same time, its posterior portion must descend faster than the anterior portion in the ratio of 12 to 5. This purpose is achieved by the lateral flexion of the child's head, the sagittal suture remaining ever midway between symphysis and sacrum, the posterior parietal bone descending more rapidly than the anterior, the whole process being termed "synclitism."

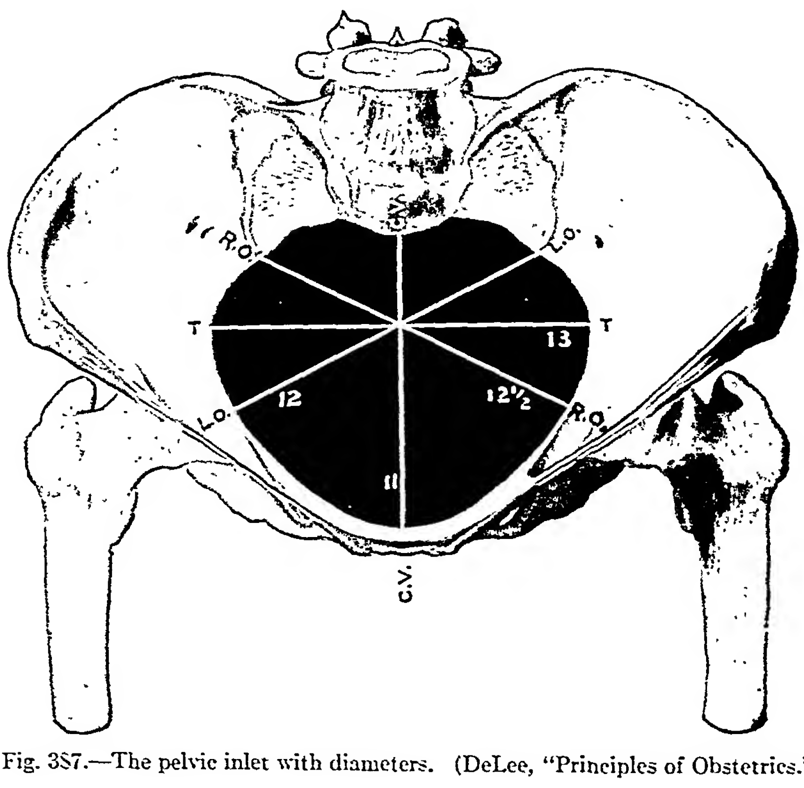

Fig. 387.—The pelvic inlet with diameters. (DeLee, "Principles of Obstetrics.")

In considering the engagement of the flexed head in the pelvic brim, one must take into account another phenomenon by which such entrance and subsequent passage is much facilitated, namely *molding*. The head of the fetus at term is rounded, the vertex of the cranium of an almost spherical form, obviously not well fitted to be thrust through a curved and resistant canal. The constantly recurring force of the uterine contractions slowly driving the vertex into the pelvis causes the cranial vault to yield to the pressure of the surrounding pelvic walls, with the result that the bones comprising the vault override each other sometimes to a marked extent. This is possible because ossification of the cranial sutures is incomplete, the connec-

boggy, edematous swelling of the soft tissue overlying the cranial bones. This swelling is called a *caput succedaneum* and is located upon the most dependent portion of the head, usually the inner surface of the parietal and the anterior part of the occipital bones (Fig. 392). The swelling is due to an infiltration of the subcutaneous connective tissue and of the tissues beneath the galea, with a *serosanguineous transudate,* accompanied by ecchymoses in the skin and hematomas of varying size in all layers of the scalp. According to Ehrenfest, it is now generally assumed that the caput is the expression of

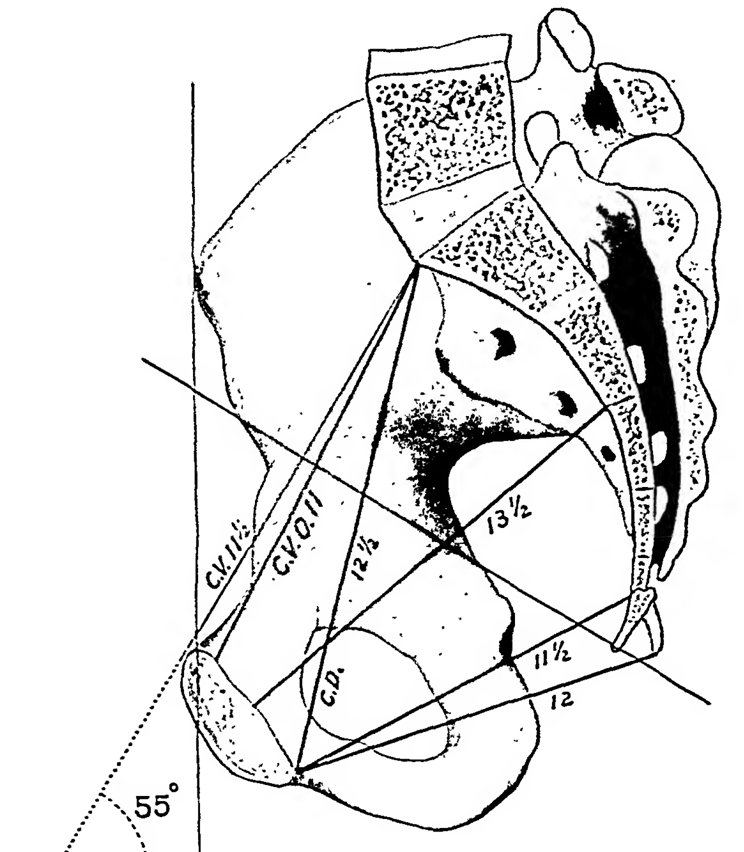

Fig. 389.—Sagittal section of pelvis showing diameters (Hodge). C.V., Anatomical conjugate; C.V.O., obstetrical conjugate; C.D., diagonal conjugate.

the difference between the atmospheric and the intra-uterine pressure, greatly increased during each uterine contraction. The location of the caput is naturally directly dependent upon the position and presentation of the child during labor and can therefore be utilized immediately after birth to determine what variety of mechanism of labor was operative. Following flexion, molding and engagement, the head, impelled by the force of the uterine contraction acting upon the fetal spinal column, begins to descend in the pelvis. In primiparae, if the vertex has entered the pelvic brim several weeks before the onset of labor, the head lies much lower in the pelvis than among mul-

3. The voluntary contraction of the abdominal muscles.
4. The straightening and extension of the fetal spine

As descent proceeds, flexion becomes more marked, the force of the uterine contraction acting to thrust down both sinciput and occiput into equal resistance, the longer lever arm of the sinciput being detained while the occiput descends. The purpose of flexion is obvious, there being presented to the birth canal a suboccipitobregmatic diameter of 9 cm. with a circumference of 31 cm., as opposed to an occipitofrontal diameter of 11 cm. with a circumference of 35 cm.

Internal rotation is the turning of the head from the oblique into the anteroposterior diameter of the pelvis, and represents the most marked differ-

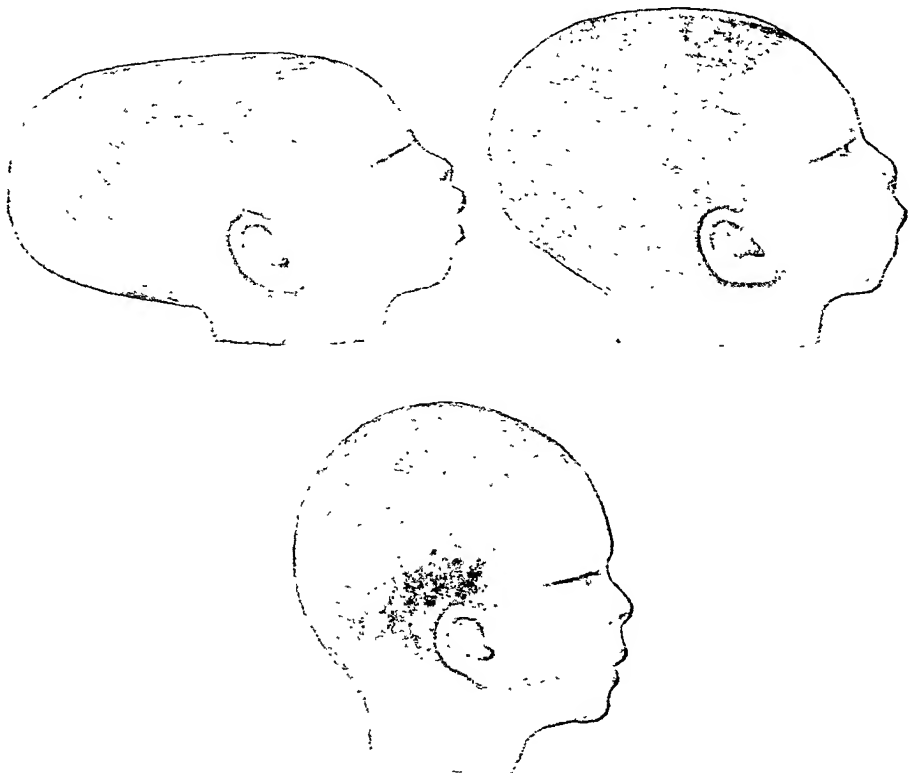

Fig. 392.—Caput succedaneum at birth; its disappearance three and ten days later. (Williams, "Obstetrics," D. Appleton and Co., Publishers.)

ence between the mechanism of labor in man and the lower animals. In the latter the long, wedge-shaped head of the fetus, without frontal prominence, and the extreme inclination of the pelvis permit the head to slide through the long anteroposterior diameter without twisting or rotation. In man the development of the forebrain with its high frontal bulge and the reduction of the obliquity of the pelvis renders it necessary that the head should enter in one diameter—the oblique, and leave in another—the anteroposterior (Figs. 393–396). Internal rotation begins when the most dependent portion of the head meets the resistance of the pelvic floor and the cause of the movement

has caused great debate among obstetricians. The older view was that the shape of the pelvis alone determined the turning, inasmuch as the superior

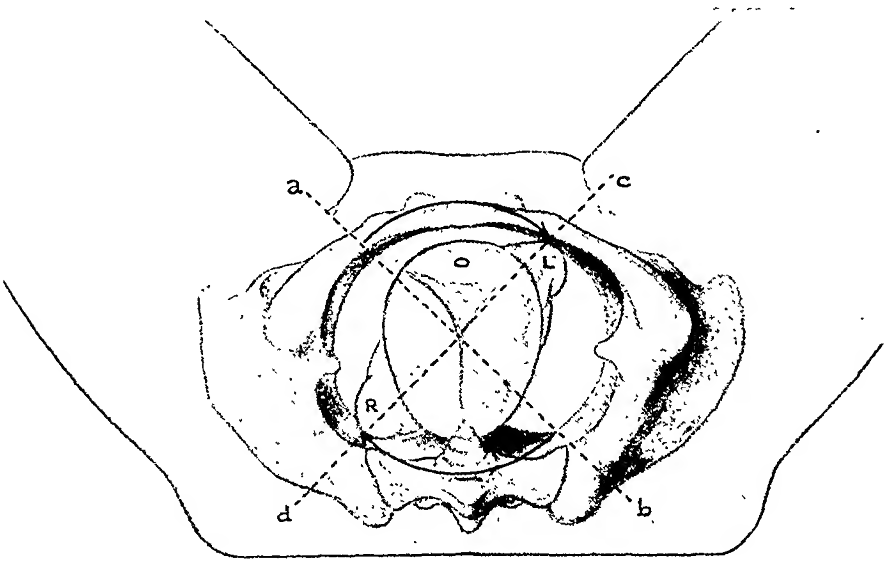

Fig. 395.—Rotation continued. With the shoulders unengaged and upon the pelvic brim they rotate with the occiput.

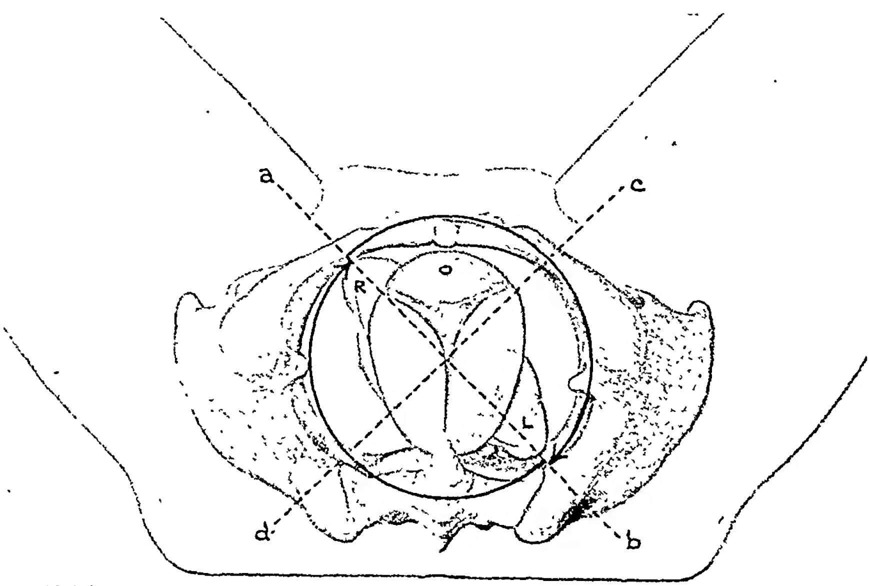

Fig. 396.—With the shoulders unengaged they rotate in an atypical mechanism over-rotating and engaging in the left oblique diameter.

strait presents a long, transverse diameter and the interior strait a long anteroposterior one. However, when the coccyx is displaced backward in labor,

the spine of the ischium, as being the dominant causative factor in this phenomenon.

The upper portion of the pelvic floor represents a curved plane running forward, downward, and inward. These directions, therefore, are imposed upon any movable body impinging upon the pelvic floor and impelled by a force from above (Fig. 397).

In addition to these inclined planes of the pelvic muscles and fasciae, there is the contour of the bony pelvis which practically follows the same direction. The spine of the ischia projects sharply into the lumen of the pelvis

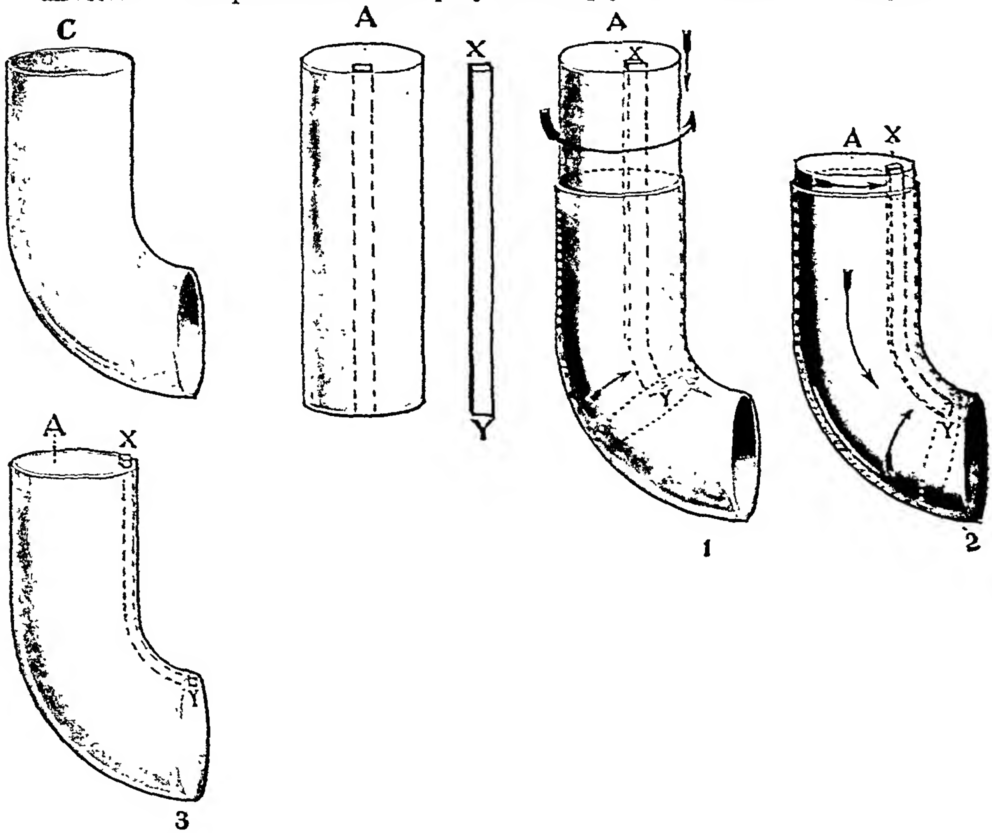

Fig. 399.—Action of an unevenly flexible cylinder when forced through a curved passage. The cylinder A has a flat steel rod at X Y. This rod cannot bend on the edge, only on the flat. Therefore, in order to accommodate itself to the curve of C, it must rotate the cylinder A. Note the direction of the arrows. (DeLee, "Principles of Obstetrics.")

and anterior to the spine, the sides of the pelvis curve gently downward, forward and inward, thus forming a part of the lateral inclined planes.

The pelvic floor, or that portion of it composed of the levator ani muscle, forms a sort of trough or sling down which the occiput slips until it is directed under the pubes, the long axis of the fetal head adapting itself to the long axis of the trough in which it lies, *i. e.*, anteroposteriorly. It has been shown that the occiput is generally lower than the sinciput, owing to the flexion of the head, and therefore it is the first portion of the fetal ellipse to meet the resistance of the pelvic floor and to be impelled along the lines of the pelvic

Disengagement, Extension, and Birth of the Head.—Internal rotation being completed, the sharply flexed head reaches the vulva and then undergoes another essential movement, that of extension. At this time the occiput is under and beyond the pubis, the nape of the neck lying under the arch of the pubis and the forehead has passed beyond the coccyx. Now the resultant of two forces, the pressure of the uterine contraction from above and the elastic resistances of the musculofascial sling forming the pelvic floor from below, begins to act, and the parietal eminences being held firmly

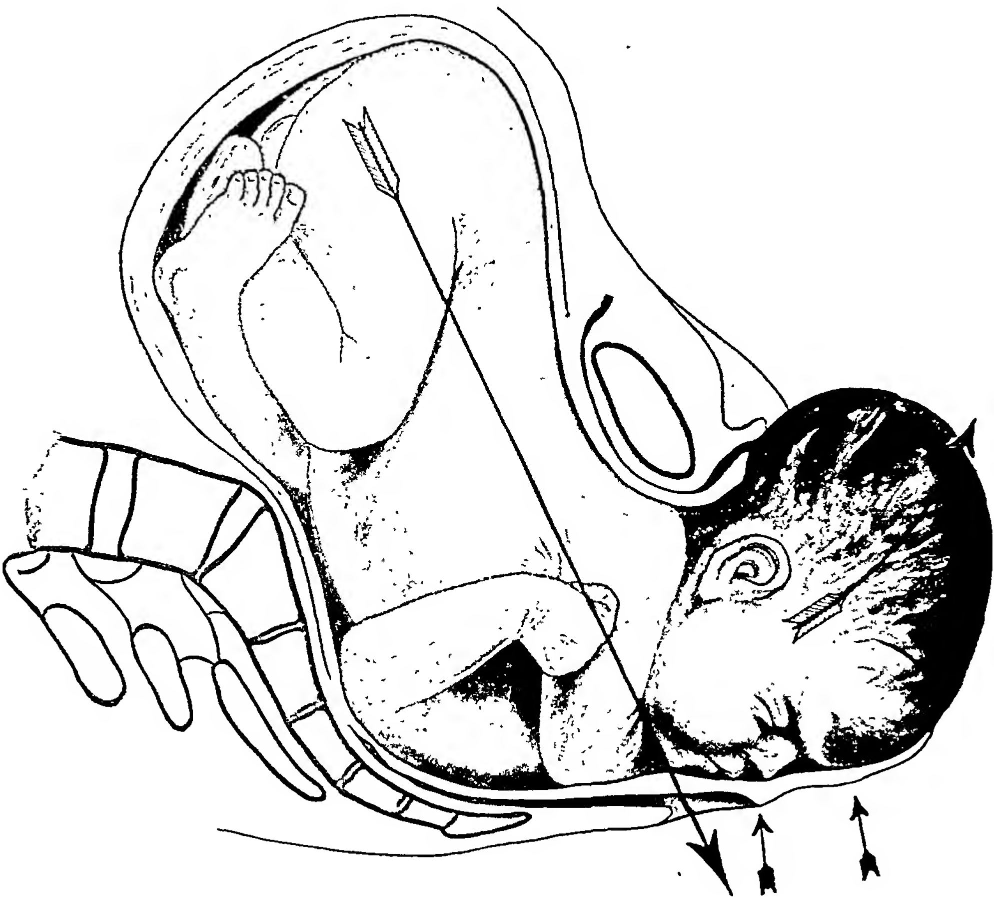

Fig. 401.—Movement of extension and disengagement. (DeLee, "Principles of Obstetrics.")

by pressure of the lateral fibers of the levator ani near the pubis, the chin leaves the chest, the occiput appears in front of the pubis, the brow greatly distends the outer portion of the perineum and is born by continued extension, the bregma, forehead, nose, mouth, and finally the chin escaping over the greatly stretched anterior aspect of the perineum. Immediately after birth the head falls forward, the chin coming into contract with the anal region (Fig. 401).

Restitution.—As soon as the head is born in an L.O.A. the chin rotates slightly to the mother's right, the sagittal sutures resuming the oblique po-

asmuch as the movement is a spiral arc beginning as soon as the occiput meets the resistances of the upper segments of the pelvic fasciae, at the level of the ischiatic spines, and continuing until the turning has been completed at the vulvar outlet. In general, it may be stated that the greater the disproportion and the more imperfect the flexion, the lower in the pelvis will rotation occur.

In a small proportion of cases the occiput, instead of rotating anteriorly, will turn in the opposite direction and finally come to rest in the hollow of the sacrum. The reason for this anomalous motion has not been established definitely but it does occur frequently in the presence of funnel pelves, and also when deflexion is a prominent factor. Under these conditions the greater fontanel occupies a lower position in the pelvis than does the small, and consequently the former first strikes the plane of the pelvic floor and is directed forward, downward and inward, the occiput so being directed backward.

An interesting experiment has been conducted to demonstrate the action of the inclined pelvic planes. The head of a fetus was repeatedly forced through the pelvis of a female cadaver and it was found that as long as the integrity of the pelvic floor was preserved, the occiput rotated anteriorly, but when the muscles and fasciae were stretched and torn from many repetitions of the maneuver, the occiput either failed to rotate at all or turned backward toward the sacrum.

Mechanism When the Occiput is in the Hollow of the Sacrum.—There are two methods by which delivery may take place: First, the head is thrown into extreme flexion, with an enormous increase in the occipitomental diameter, the chin is pressed firmly against the neck and the fetal body becomes a rigid cylinder, which cannot accommodate itself to the sharply angulated birth canal, which later must either stretch greatly or tear, to permit the passage of the unbendable fetus. Under such circumstances descent, under powerful uterine and abdominal contractions, continues until the occiput is forced either over or through the lacerated perineum, after which the brow and face appear under the symphysis, the head being born in extension.

A second mechanism may occur in the more deflexed cases. Here the forehead becomes the point of direction, descent continuing until the brow appears at the vulva, the glabella lying under the pubis. The occiput now escapes over the perineum by partial flexion, the long occipitofrontal diameter of the head usually producing extensive laceration, after which extension occurs, the brow, face, and chin successively slipping out from under the pubis. The remainder of the mechanism is that of anterior presentation.

The Mechanism of the Third Stage of Labor.—The birth of the placenta and membranes comprises two distinct mechanisms, separation of the placenta from the uterine wall, and extrusion of the organ. Separation does not begin until after the birth of the child, the placenta remaining firmly fixed *in situ* until after this event, the intra-uterine pressure being an important factor in maintaining this relationship. During labor there is a slight decrease in the area of the cavity of the uterus due to its contraction, and the placenta, accommodating itself to this smaller site of attachment, becomes thicker, its margins rounded. At this time there is probably a slight separation of the central portion of the placenta from the uterine wall with rupture of the vessels in the spongiosa and a small hematoma behind the center of the organ. When the child has been delivered the uterus is greatly decreased in size, and the

CHAPTER XXIV

THE CONDUCT OF NORMAL LABOR

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The procedures described in this chapter are based in general on the methods taught and used by the author at the Michael Reese Hospital, in Chicago.

Deliveries are still, for the most part, conducted in the home, though it must be conceded that any delivery may become a highly specialized surgical procedure. For this reason it was determined to emphasize the hospital point of view in the hope that those responsible for delivery in the home would approximate, as closely as conditions might permit, the principles and practices set forth here.

The armamentarium for use by the physician in the home should include sufficient gloves and enough instruments to meet any problem short of mutilating operations and cesarean section.

The home equipment should include the conversion of the bedroom into a dust-free and spacious delivery room. Good lighting is important. The bed can be reinforced with the traditional ironing board under the mattress and there should be a sufficiency of sterile supplies, boiled water and hand basins.

When possible, a medical assistant trained in anesthesia should be available to remain with the patient and assist in the actual delivery, if necessary.

Asepsis.—The greatest single factor which converts an otherwise normal delivery into a pathologic problem is infection. Injury to the birth canal occurs in every delivery. These traumata may be gross or invisible; they may involve the external genitalia, the vaginal tube, the cervix and its attachments, and lastly and perhaps most important, the placental site, in every instance a potential atrium for infection. It is accepted medicolegally that a normal healthy woman may go through labor without any vaginal examinations, surrounded by all the safeguards and care afforded by the best maternities, under the guidance of a well-trained obstetrician, and yet may die of septicemia arising in the birth canal. Nevertheless, the extreme rarity of such an occurrence justifies an insistence on every measure aimed at the prevention of infection. For this reason those who come in direct contact with a woman in labor must avoid the transmission of any type of infection to the parturient. Both physicians and nurses in obstetrics must at all times aim to keep their hands free from contact with pathogenic organisms. In addition they must scrub their hands vigorously preparatory to caring for the patient. Furthermore, they must guard themselves against the nose and throat infections which may be the source of an

This observation has no direct bearing on the conduct of normal labor but may serve to forewarn the existence of a placenta praevia cesaria and should, therefore, be included in a routine abdominal examination.

The state of the cervix is the most significant single index of the progress of labor. Because this is so, and because the vagina offers easy access to an investigation of the condition of the cervix, untold numbers of women

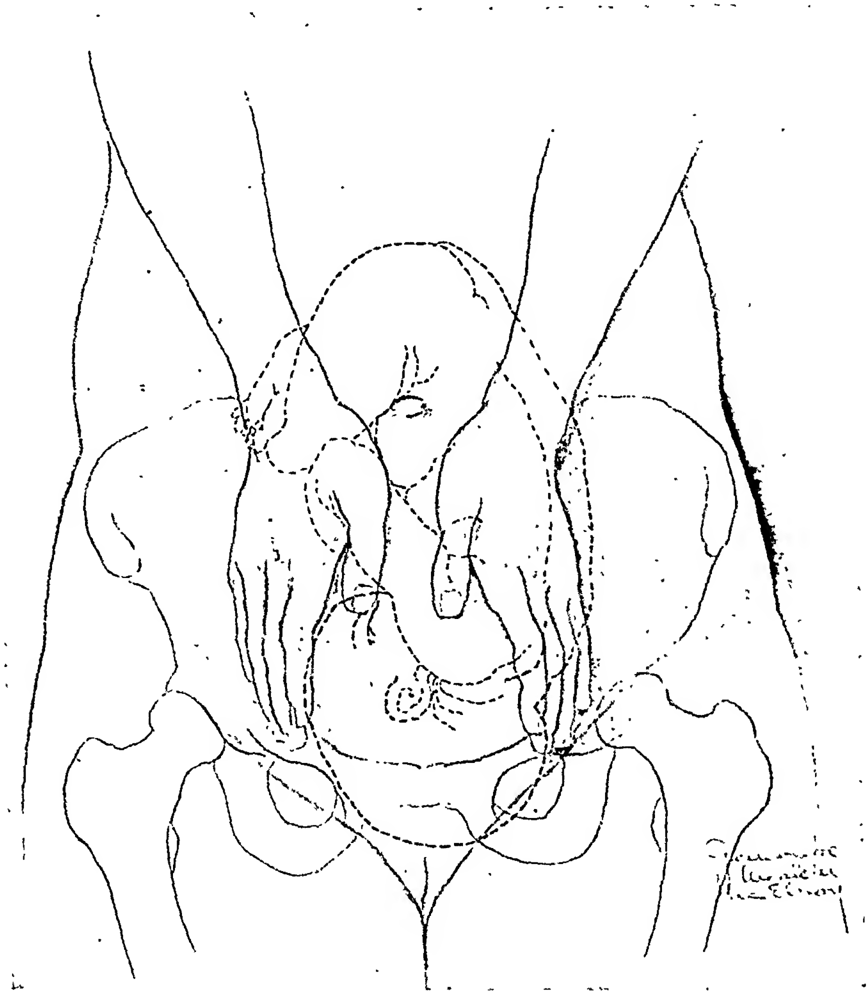

Fig. 407.—Engagement determined by abdominal palpation. The largest transverse diameter of the fetal head, the biparietal, is just through the plane of the inlet. Note that the portion of the fetal head which is still above the pelvic inlet converges under the examiner's hands. Therefore, the hands closely applied to the fetal head will likewise converge upward.

have been subjected to unlimited vaginal examinations more or less carelessly carried out by midwives and physicians and have paid for this alleged obstetrical carefulness with their lives or with years of invalidism.

Rectal Examination.—The introduction, by E. Ries[30] of the rectal method of examination in the conduct of labor ranks as one of the major advances

and, conversely, that the percentage of pelvic infection is definitely decreased. There appears, however, to be practically no difference between group

Fig. 409.—Effacement of cervix. Complete obliteration of the cervico-uterine angle on the vaginal surface. The edge of the external os is thin.

examinations vaginally and group examinations rectally. If then, as most workers agree, the rectal examination is only 90 per cent efficient for diagnosis

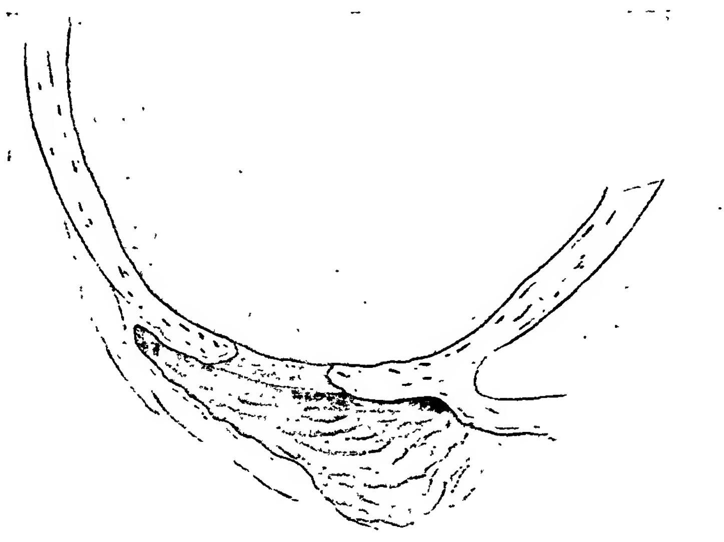

Fig. 410.—Effacement of cervix. The edge of the external os is thick but the cervical canal no longer exists and the cervico-uterine angle is obliterated. Effacement is complete.

and if it is especially inadequate for abnormal and pathologic cases, it would seem that one vaginal examination is desirable in every labor, particularly

This is spoken of as *engagement*, since it signifies that the greatest transverse diameter of the head, the biparietal diameter, has passed the plane of the inlet.

The importance of recognizing engagement abdominally or from below is deserving of reiteration. Engagement in the primipara, the unknown quantity obstetrically speaking, signifies that the fetal head has successfully passed the first natural barrier, the bony ring or inlet of the true pelvis. This obstacle is not only the first but the most frequent and perhaps the most serious of all the hindrances to the uneventful progress of labor.

Descent is a cardinal movement in the mechanism of labor. However, it is not a steady downward progression. Once the head is fully engaged it usually maintains that level until dilatation and effacement of the cervix are completed.

Nonengagement of the fetal head at the onset of labor in the primipara is by no means unusual or necessarily pathologic and is not indicative of a

Fig. 412.—The Hillis impression maneuver. The head is directed into the pelvis by pressure on the fundus of the relaxed uterus. The level is determined by rectal examination.

disproportion between the head and the inlet. In a majority of these patients the fetal head will be found engaged after a few hours of labor. In this type of patient disproportion may be ruled out by either the Mueller[27] or the Hillis[13] maneuver. In the original Mueller maneuver the patient was anesthetized, a finger inserted into the vagina and the other hand used to make downward pressure on the fetal head to determine whether it would enter the pelvis. If the head reaches the spines of the ischium, there is no disproportion. If it enters the pelvis to a lesser degree, there is some disproportion which must await a test of labor. This information may be obtained equally well by rectal instead of vaginal examination, and usually without anesthesia. Hillis recommends downward pressure on the fundus rather than on the fetal head, combined with rectal examination. The uterus must be relaxed. The method is practically painless, requires no special skill, and no anesthesia in 95 per cent of patients.

In the multipara the fetal head is usually found at the inlet rather than

Subsequent rectal examinations may be carried out at any time during the course of labor without jeopardy to the patient. It must be pointed out, however, that here, as in other branches of surgery, brusk or too frequent manipulation of any part may result in injury. Ulceration of the rectal mucosa may be produced and anal fissures may result. As the cervix dilates and the examiner seeks more information concerning the presenting part, the temptation is great to thrust the tip of the examining finger into the domain of the lower uterine segment. Between the rectal finger and the lower uterine segment there is the rectovaginal septum which is very thin at this distance above the perineal body and can easily be invaginated into

Fig. 414.—Technic of rectal examination. Completion of the examination. Anal region cleansed by downward sweep of the gauze.

the lower uterine segment by the tip of the finger. This means that all the flora, both pathogenic and nonpathogenic, contained within the vaginal tube, are carried into the zone of the lower uterine segment and massaged into its walls with a vigor depending on the intensity and frequency of the examinations. For these reasons subsequent rectal examinations during the course of labor should be limited in number and vigor, their chief function being the determination of the state of the cervix and the level of the head.

Vaginal Examination.—In private practice, where the pelvic conditions are known in advance, the obstetrician may well content himself with abdominal and rectal examinations, holding vaginal examinations in reserve for such indications as may arise.

of the internal application of mercurochrome or other antiseptics, if widely promulgated, might result in an increased morbidity rather than a decreased

Fig. 415.—Draping the patient. The patient has been scrubbed, is resting on a heavy sterile absorbent pad and sterile leggings have been tied in place.

one. The favor with which the procedure has been received justifies continued investigation.

Fig. 416.—Patient completely draped. This draping is identical for vaginal examination or for delivery.

It is desirable to cover the patient as quickly as possible after the preparation for vaginal examination, as the prolonged exposure is frequently the

to eighteen hours in the primipara and ten to twelve hours in the multipara. This is the most trying part of the confinement for the patient, attendants, and obstetrician. As the contractions become increasingly severe, frequent, and prolonged, the endurance of the patient is taxed and her morale is undermined. Unaided she is no longer able to combat successfully this drain on her physical and moral stamina. Modern obstetrical practice requires that she be aided in so far as possible without jeopardizing the safety of mother or child.

The presence of the obstetrician is ordinarily the most important factor in accomplishing these ends. However, the exigencies of practice and the occasional untoward effect of a too constant attendance on the patient justify the habit of most obstetricians of absenting themselves from primiparae during the greater part of the first stage of labor. The patient should be encouraged to remain active for as long as the pains will permit. Walking and sitting are preferable to bed rest. After the patient has been prepared and it is definitely determined that she is in true labor, she should remain within the premises in which she is to be confined. If the membranes have already ruptured, she should be required to wear a sterile vulvar pad, not merely to absorb the flow of liquor amnii, but also to avoid the contamination from without while she is ambulatory. After the fetal head is engaged, usually at the beginning of labor in primiparae and soon after the onset of labor in multiparae, there is no longer danger of prolapse of the cord. If, however, the fetal head is fixed in the inlet and it is desirable to have the patient walk, a firm abdominal binder should be applied with the purpose of maintaining the fetal head firmly against the bony ring of the inlet. When the head is floating and the membranes are ruptured, the binder should be applied but the patient must be kept in bed until the contractions have fixed the head.

The state of the bladder is a matter of prime importance throughout the conduct of labor. Failure to empty it frequently may result in delayed engagement or rotation, a separation of the bladder from the pubovesicocervical fascia, a partial destruction of the fascia with a resulting cystocele in the puerpera and undue bleeding in the third stage. For these reasons the patient should be encouraged to urinate at least every two hours, even though it is true that as labor advances the patient's intake is diminished, water is lost by perspiration, and the accumulation of urine in the bladder is lessened. However, inspection of the lower abdomen may reveal a beginning distention of the bladder of which the patient is sometimes unable to relieve herself because the urethra or bladder outlet is compressed between the fetal head and the symphysis pubis. In such instances it is desirable that the patient be properly scrubbed and catheterized. The soft rubber catheter is the safest type of instrument for this purpose. Glass catheters may break within the bladder or urethra, and the metal catheter, if used to overcome some resistance, can result in more or less severe traumatization of the urethral mucosa. If difficulty is encountered in passing the rubber catheter because of the compression of the urethra, the patient must be prepared as for a vaginal examination and the index finger insinuated between the symphysis and impacted fetal head just lateral and parallel to the urethra. With the finger held in this position the urethra is released from its compressed state and the catheter readily enters the bladder.

if labor becomes prolonged. The addition of carbohydrates in any form will tend to prevent acidosis.

Analgesia and Anesthesia.—The subject of relief of pain has run the whole gamut, from the dictum of the most educated members of the public, when ether and chloroform were first advocated, that woman was meant to suffer the pangs of labor, and that drugs to relieve her were heretical, to the opposite extreme of complete oblivion for the mother from the beginning to the end of labor under the influence of morphine and scopolamine or barbituric acid derivatives.

Chief among the factors which have shaped the development of analgesia and anesthesia in labor is the fact that labor is a variable period which may properly extend from a few to twenty-four hours or even longer, being in this respect totally different from the requirements of analgesia or anesthesia in ordinary surgical procedures. Since the most uneventful labor may at any time develop a pathologic aspect which demands immediate operative delivery, the use of drugs whose effect is long continued and not removable is a questionable procedure. Moreover, the woman in the final hours should receive only such anesthetic drugs or chemicals as will permit of the delivery of the fetus free from any effects of such drugs. From the standpoint of the progress of labor in its early stages, it has already been indicated that it is desirable when possible to keep the patient ambulatory. For these reasons relief should be obtained at appropriate intervals during the first stage rather than continuously. The problem may, therefore, be properly divided into first-stage and second-stage treatment.

Two drugs stand out as preeminently useful in the first stage, morphine sulphate and chloral hydrate. A full dose of morphine, from $\frac{1}{6}$ to $\frac{1}{4}$ grain hypodermatically (0.010 to 0.015 Gm.), will give the patient almost complete relief of pain and a definite rest for a period varying from two to four hours. Chloral hydrate has a synergistic action on the cervix when given with the morphine. Administered per rectum in doses of 20 to 30 grains (1.3 to 2 Gm.), it definitely accomplishes a more rapid relaxation and dilatation of the cervix. Its effect is most noticeable when the cervix is apparently resistant and still less than one half dilated. The morphine may be repeated if a second rest period is deemed necessary. It should be emphasized that morphine must never be administered hypodermatically when it is probable that labor will terminate within two or three hours, as it takes at least that long for the maternal organism to oxidize the morphine. This will avoid the birth of a narcotized infant. On this basis morphine would ordinarily not be given after the cervix is two thirds dilated in primiparae and one third dilated in multiparae, since in the latter one or two contractions may complete the dilatation and drive the fetal head out.

Experience has convinced those responsible for the conduct of most of the important clinics of the world that the disadvantages of early morphine administration with repeated and even carefully regulated doses of scopolamine are greater than the advantage of the amnesia which this method aims to produce.[5] The disadvantages are that the method is successful in not more than 75 per cent of patients, that there is always the risk of delirium in which the patient either contaminates herself or must be actually restrained, that there is a definite retardation of the second stage with an increase in the number of operative deliveries, that the newly born infant not infre-

pains, must be regarded as a potential respiratory irritant. When neither ethylene nor nitrous oxide is available, ether should be the method of choice for second-stage analgesia and terminal anesthesia.

The administration of chloroform vapor has been generally discarded because of the proved deleterious effects of the drug.

CONDUCT OF THE SECOND STAGE OF LABOR

The average duration of the second stage is two hours in the primipara and from a few minutes to one and one-half hours in the multipara. The first difficulty experienced by the attendants is the determination of the time when the first stage has ended and the second stage has begun. Obstetrically, the definition is precise; the first stage has ended when the cervix is fully effaced and completely dilated. Clinically, the behavior of the patient is regarded as a further index, in that with the commencement of the second stage and the advancement of the fetal head, pressure is now exerted on the ganglia of the sacral plexus and the cervix, and the patient responds by voluntary expulsive efforts. However, the multipara who has learned that her efforts seemingly hastened the termination of labor, may bear down prematurely. The fetal head is violently thrust against the partially dilated cervix, resulting in lacerations of the cervix and of the pubovesical fascia.

Rupture of the membranes occurs ordinarily at or about the time of complete dilatation of the cervix. Exceptions to this, however, are numerous since, in many instances, rupture occurs at the beginning or even preceding the onset of labor. In others the membranes bulge through the partially dilated cervix and remain intact long after the cervix is fully dilated, the fetus occasionally being born with a caul. Rupture of the membranes, therefore, is not reliable as a criterion for the end of the first stage of labor.

There is only one way in which a certain diagnosis of the onset of the second stage of labor can be made, and that is by rectal or vaginal confirmation of complete dilatation.

Occasionally, and most commonly in multiparae, the contractions are vigorous, rectal examination indicates complete dilatation, the head is at the spines but labor does not progress. While there are numerous types of pathology which may hinder the normal progress of labor, a vaginal examination is quite likely to reveal the anterior lip of the cervix incarcerated between fetal head and symphysis, markedly edematous and becoming steadily more so. If this swollen rim of cervix is pushed upward with two fingers, and held up continuously during one or two contractions, it will slip over the head and the head will promptly advance.

When complete dilatation is definitely established, and not until then, is it proper to encourage the parturient to begin her bearing-down efforts.

For the proper application of these efforts the patient, and particularly the primipara, must be instructed to concentrate her expulsive efforts toward the rectum, just as if she were attempting to overcome the resistance of a difficult evacuation. She should be instructed to keep her hips and feet in contact with the bed, her knees flexed and widely separated, and her hands grasping a suitable hold placed alongside her hips or above her head on which to pull or to push, according to the technic preferred. At the same time she should be told that her efforts will be more effective if she will hold her

engaged, to prevent a rush of liquor from carrying the cord with it. Thereafter the liquor is released gradually, the abdominal hand using the head as a plug from above and the vaginal hand against the vulva acting as a plug from below.

A similar technic of controlled rupture of membranes may be employed in the multipara with an unengaged head in whom dilatation is almost complete and in whom the membranes are unusually tough.

Mention has been made previously of the value to the parturient of the availability and occasional presence of her accoucheur. As labor advances it becomes more and more essential that he remain constantly available to his patient. In the multipara in vigorous labor it is well known that labor may advance from 3 to 4 cm. dilatation in the first stage to complete dilatation and visibility of the fetal head in one or two contractions. Young primiparae in the optimum age of eighteen to twenty-two may pass through the second stage so rapidly as to catch the inexperienced physician unawares.

Treatment of the Perineal Body.—The adaptability of the structures in the pelvic floor is remarkable in that it provides for the passage of so large a bulk as the normal fetal head and a subsequent functional restoration of the vaginal tube and its supporting musculature and fascia without damage, except at the posterior margin of the introitus. There are innumerable factors which may modify so perfect an outcome, such as the age of the primipara, in whom advancing years have converted the elasticity of her pelvic fascia and submucous connective tissue into a more or less unyielding fibrous barrier; congenital deficiencies in these same supporting structures; alterations due to childhood inflammations with their resulting scar formation; abnormal pelves, such as the funnel pelvis in which the descending rami of the pubic bones form a masculine angle rather than the usual feminine arch, thus compelling the fetal head to emerge in the posterior zone of the outlet (availing itself of the room indicated by the increased posterior sagittal diameter of Klien[23]), but at the expense of the perineal body; undetectable disproportion revealing itself only as the head is distending the vulvar orifice; advanced ossification of the fetal skull with a lowered capacity for molding, and too rapid advance of the fetal head.

The existence of so many and varied types of pathology, all of which play a rôle in the final delivery of the patient, has led to a voluminous literature on the treatment of the perineal body. The range of suggestions extends from ultraconservatism to extreme radicalism. On the one hand the normal primipara is permitted to accomplish her own delivery with such protection of the perineal body as can be given by manipulation with a subsequent repair of the lacerations that may have occurred. On the other hand there is the opposite extreme of surgical anesthesia, deep incision into the perineal body and routine forceps extraction when the fetal head has reached the pelvic floor and is not yet visible.[12]

It is true that in approximately 50 to 60 per cent of all primiparae who can and are permitted to deliver themselves there will be visible lacerations. These injuries have been classified for purposes of description as first degree when the mucocutaneous junction at the introitus is torn, second degree when the musculature of the perineal body is involved to any extent, and third degree when the laceration has extended posteriorly through the sphincter ani with more or less damage to the anterior rectal wall.

tive delivery. It is the posture generally used for spontaneous delivery as well.

In the conduct of the actual delivery, the decision having been made to await the behavior of the perineal body under the distending effect of the advancing fetal head, it is possible by a manual control of the fetal head to retard a too rapid emergence, to accomplish delivery in the suboccipitobregmatic diameter rather than the occipitofrontal or occipitobregmatic diameter, and finally to accomplish extrusion of the head between contractions by means of a modified Ritgen grip.

The first and second of these purposes are accomplished by counterpressure on the fetal head for the purpose of maintaining and increasing

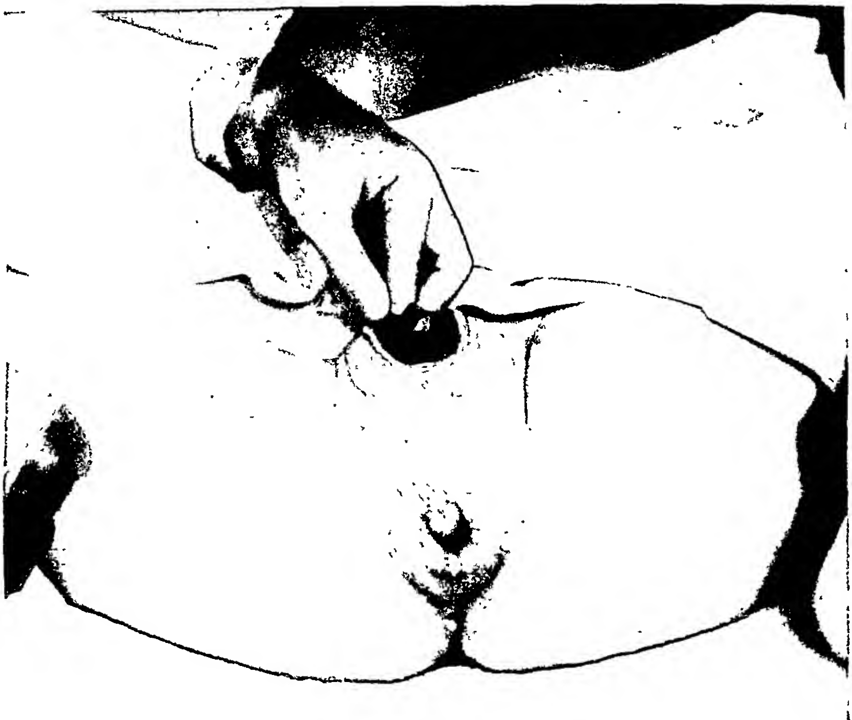

Fig. 424.—Delivery in the dorsal posture. Counterpressure is used against the fetal head to prevent a too rapid emergence and to maintain and increase flexion of the fetal head. This accomplishes delivery in the suboccipitobregmatic diameter.

flexion of the head. This permits the occipital protuberance to pass from under the symphysis pubis before extension and expulsion of the head are allowed to occur. The extrusion procedure between contractions is accomplished by a widely spaced grip of the surfaces lateral to and at the level of the anus, the gloved hand being protected from contamination by a large pad placed over the anal orifice. This grip should be taken when the parietal bosses are about to be born. At this stage the lateral compression will be applied beneath the fetal malar eminences and not in the eye sockets and will prevent recession of the head. The other hand is used to carry the anterior vulvar commissure back over the occiput, while now the first hand, by a

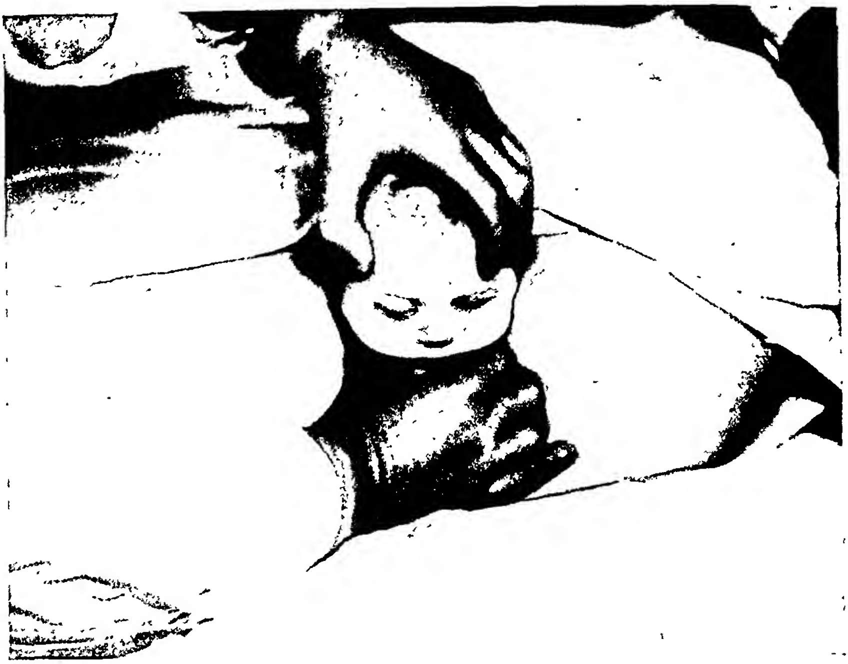

Fig. 427.—Delivery in the dorsal posture. Birth of the fetal head. The final extrusion of the head can be aided by pressure on the fundus uteri.

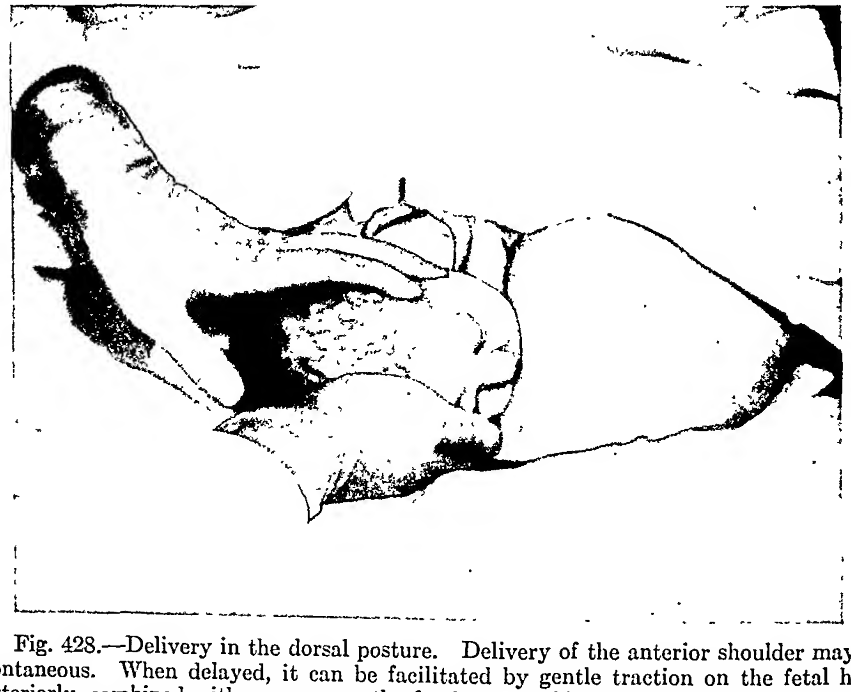

Fig. 428.—Delivery in the dorsal posture. Delivery of the anterior shoulder may be spontaneous. When delayed, it can be facilitated by gentle traction on the fetal head posteriorly, combined with pressure on the fundus. Avoid compression of the vessels of the fetal neck.

Fig. 431.—Delivery in the lateral posture. The accoucheur is standing at the back of the patient facing the lower extremities. The arm next to the patient encircles her superior thigh from above downward and is rested on the sterile sheets as shown. The thighs are kept separated by an assistant who holds the upper knee or by placing the upper foot on the lower knee as shown.

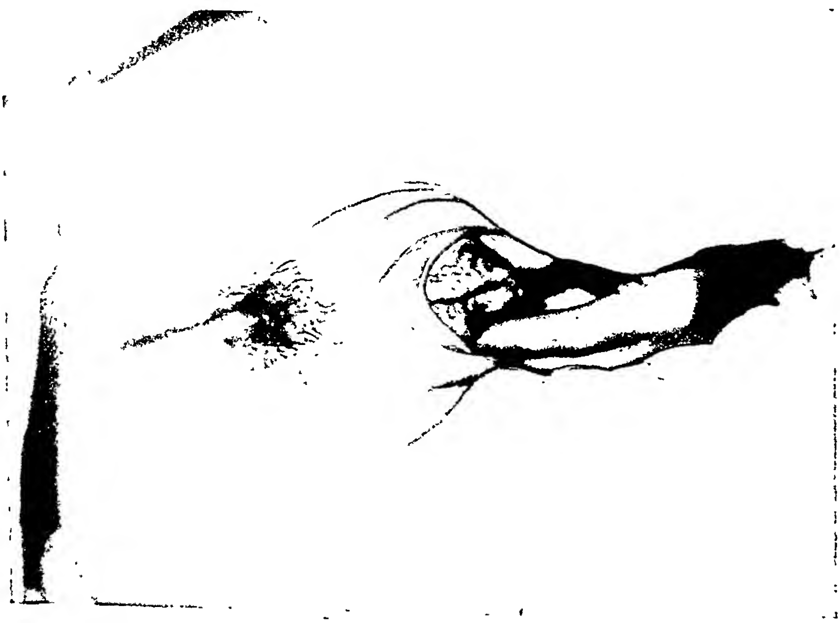

Fig. 432.—Delivery in the lateral posture. As the head advances the encircling hand is used for retardation of the fetal head.

hand is used finally in the modified Ritgen expulsive maneuver. The advantages offered by the lateral delivery are that the patient's expulsive power is markedly diminished, the control of the head is more complete, a better protection for the perineal body is assured, and it is possible to maintain a more perfect asepsis because the anal field is in plain view. For these reasons the author prefers and recommends the lateral posture for spontaneous delivery.

It should be emphasized that episiotomy is always preferable to deep or multiple or sphincter tears and the obstetrician, even though he has judged

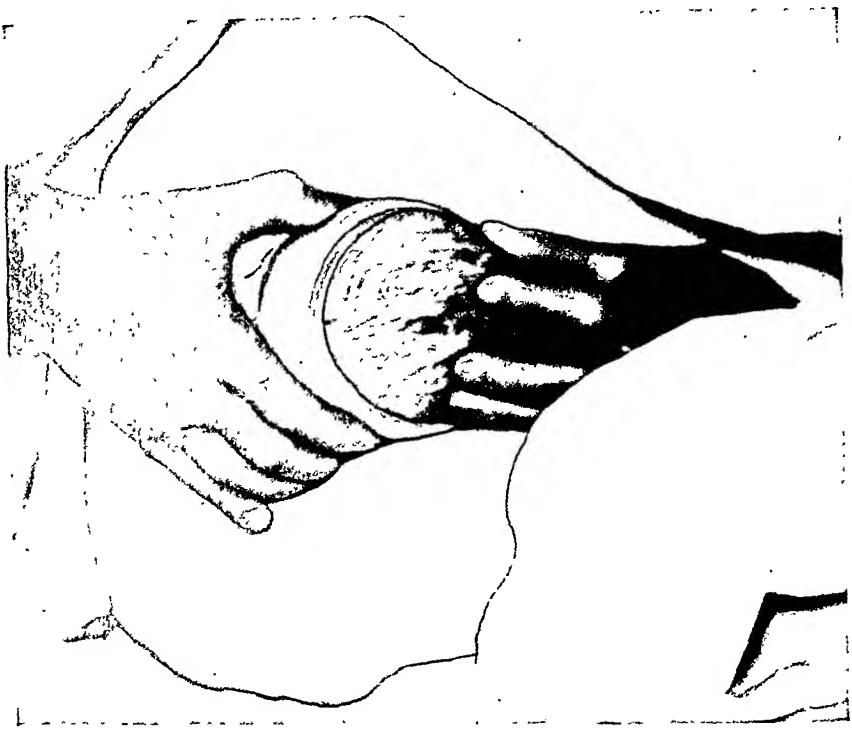

Fig. 434.—Delivery in the lateral posture. The head is ready to be delivered, preferably between contractions. The encircling hand has increased flexion, the occiput is delivered, and the parietal bosses are just coming through the vulvar ring. The palm of the other hand is laid over the anal orifice from which it is protected by a large pad of moist sterile cotton. The thumb and fingers grasping the para-anal region in a widely spaced grip (modified Ritgen grip) now serve to express the head gently. Pressure on the fundus uteri (Kristellar) may be used to aid in the final delivery of the head.

conditions to be ideal for delivery without this incision, must be prepared at any moment to carry it out if the behavior of the perineum under distention seems to justify it.

During the many hours which have preceded the actual birth of the infant the heart tones have been the index of the condition of the fetus. As the contractions accelerate and intensify, the use of the stethoscope becomes increasingly important. When the fetal scalp comes into view and becomes increasingly exposed, it is usually possible to judge of the condition of the fetal circulation by a test of the capillary circulation in the scalp. This is

catheter technic is distinctly preferable to machine methods, such as the pulmotor or Drinker apparatus[23] at the beginning, since it insures a clear airway which is a prerequisite to resuscitation. Thereafter it can be used in combination with the respirator or it can be removed and the infant left in a machine if available. In the case of a premature infant, the difficulty of intubating the larynx with the tracheal catheter leaves only the mechanical respirator or direct mouth-to-mouth method available.

The further disposition of the normal infant includes the temporary cord dressing and the examination for any external defects. It is always desirable that the physician should be the first one to note the existence of such defects.

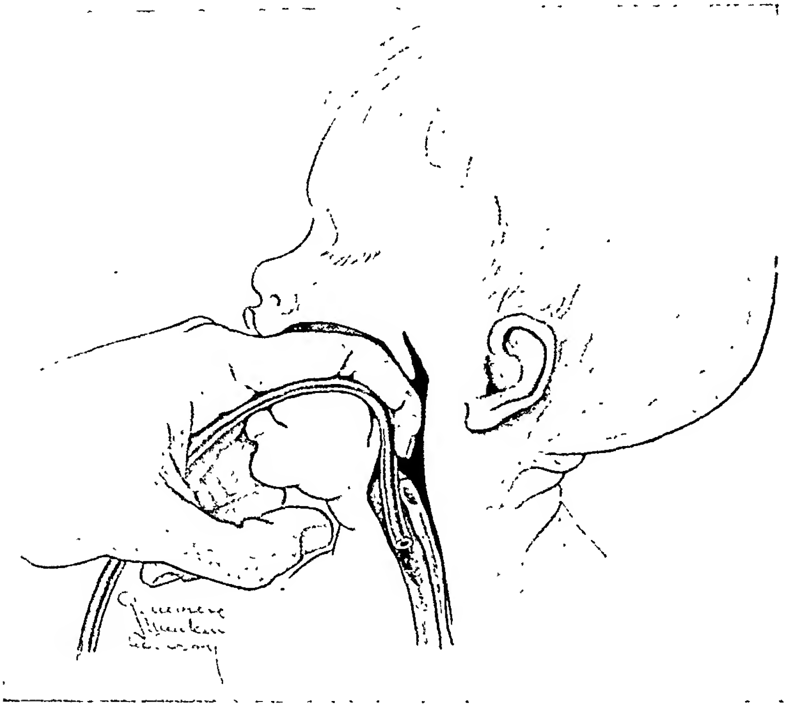

Fig. 439.—Tracheal catheter in position for artificial respiration. The left index finger is introduced over the base of the tongue and the epiglottis located. A tracheal catheter No. 14 or 15 F. is passed along the palmar surface of the hand and finger and its tip is guided forward past the epiglottis into the larynx and trachea.

The inspection should include a search for spina bifida, defects of the genitalia, imperforate anus, branchial cysts, tongue-tie (lingua fraenata), supernumerary digits, clubfoot, etc. Attention should be called to the first act of urination when observed, as occasionally the infant may have a suppression of urine for a long enough period to cause anxiety if it is not known that the urinary tract was open.

Identification Methods.—The subject of identification methods in institutions has received much attention. The method must be infallible. For this reason adhesive tape, silver nitrate or similar devices are not as safe as wrist tags or necklaces. Footprints are widely used but are less reliable than fingerprints and the latter are not practicable at this age.

of the uterus were recognized and its use was restricted to the period following complete emptying of the uterus. The routine use of ergot at the completion of the third stage of labor was finally and completely abandoned at the Michael Reese Hospital in 1918. This decision was based on studies of blood loss in parallel series with and without ergot during a period of six months. Ergot is now used only for postpartum hemorrhage and for delayed bleeding in the puerperium.

The magic effect of pituitary extract on the uterine musculature was hailed as an obstetrical cure-all. It was not long before its potency resulted

Fig. 441.—Transfer of infant from birth bed. The nurse envelopes the infant in a sterile blanket, the four corners of which she pulls through a metal ring. She then grasps the blanket beneath the metal ring. The floor nurse secures the four free corners of the blanket, counting them aloud. The gloved hand is withdrawn and the floor nurse grasps the blanket below the ring with her other hand. She then raises the infant from the bed, places her first hand under the baby and removes it to a heated bassinet.

in catastrophes to mother and fetus and led to a sharp restriction of the indications for its use. The present consensus of opinion sharply restricts the use of this drug. It may be used in 1-minim doses as part of the procedure for the induction of labor. One to 3 minims may be given to overcome uterine inertia at the end of the second stage of labor when the fetal head is at the perineum and progress has ceased. When used for this purpose, the physician must have himself and his patient prepared for immediate delivery, since the drug will induce violent uterine tetany in the occasional

type capable of carrying the whole series of birth phenomena to their normal conclusion; and, most important of all, she has been the recipient of various drugs, analgesics and anesthetics which definitely interfere with her capacities in the third stage of labor.

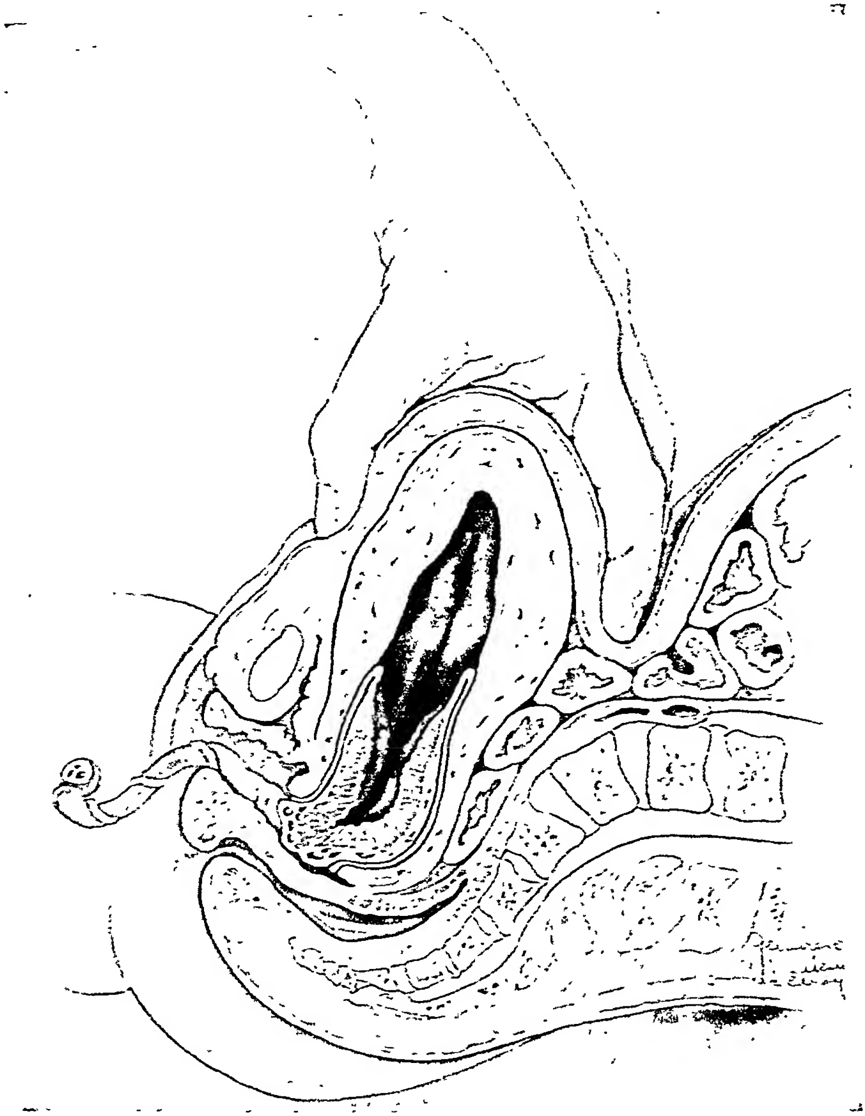

Fig. 111.—Simple expression of the separated placenta. The placenta lies in the lower uterine segment and upper vagina. The firmly contracted uterus, acting as a plunger, is pushed downward in the axis of the inlet without squeezing.

Delivery of the Placenta.—In from 10 to 15 per cent of patients in hospital and home practice today, spontaneous unaided expulsion of the placenta may be expected if separation has been normal. Painful contractions recur, these in turn call forth voluntary bearing-down efforts and the separated placenta is expelled.

within the uterus. Here one must rely on enlargement of the uterus or systemic evidences of hemorrhage. These conditions are fully discussed under Postpartum Hemorrhage.

Symptoms of shock may be combated without manual removal but if persistent require that the uterus be evacuated.

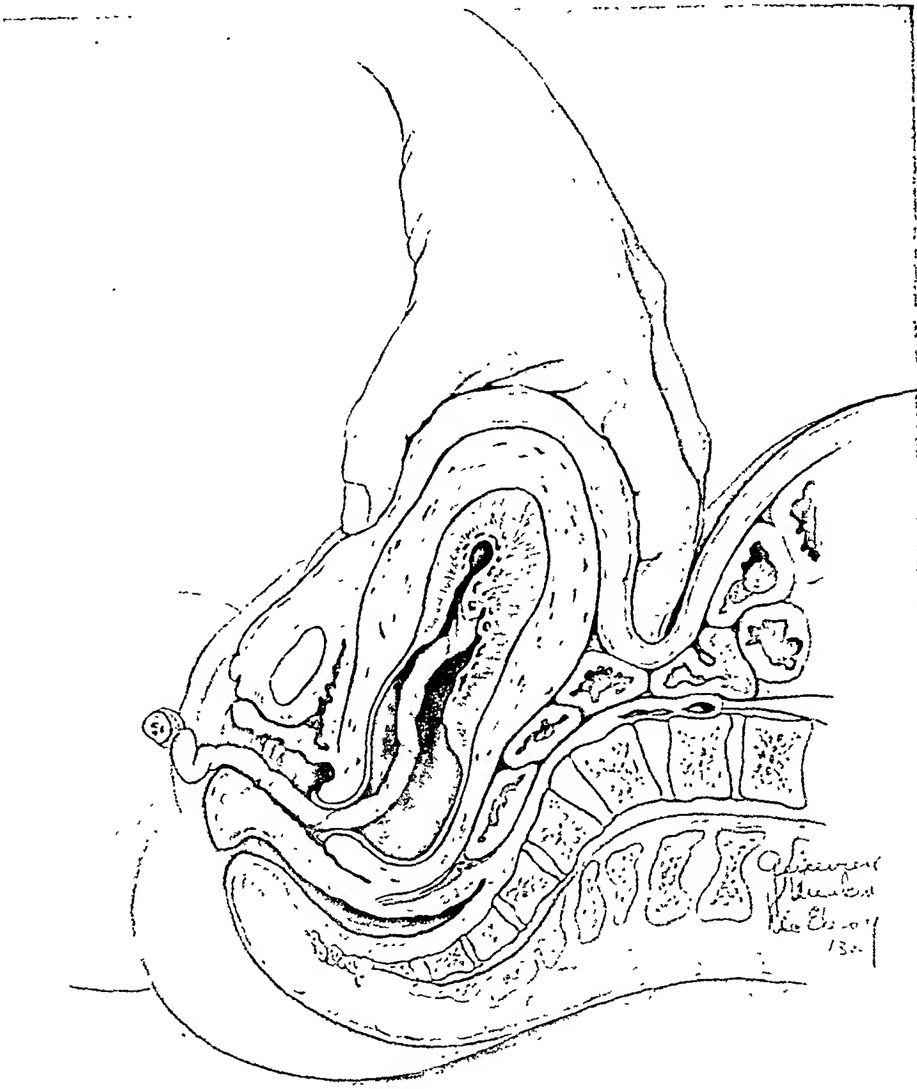

Fig. 445.—Credé method. The placenta is not yet separated. The firmly contracted uterus is compressed, not pushed downward, in order to squeeze the retained placenta out of the corpus cavity. When this is accomplished the placenta is then delivered by a downward push as described for "simple expression."

Hemorrhage is the outstanding indication for manual removal. If its source is the placental site and the Credé method fails, usually because the uterus stays relaxed in spite of massage, the indication is obvious. If

The membranes should now be reversed and the placenta examined on the amniotic (fetal) surface. Occasional abnormalities will reward careful inspection. The membranes are now held up and inspected against the light. This is the surest way to detect vessels extending out onto the membranes from the placental margin. When seen they indicate the existence of an aberrant cotyledon (placenta succenturiata). If this is present all is well; if absent it is presumably in the uterus and requires removal precisely as would a missing part of the placenta itself.

The membranes should be large enough in surface area to more than cover the whole placenta. Retention of membranes does not justify invasion of the uterine cavity for their removal. If they are missing in part or whole

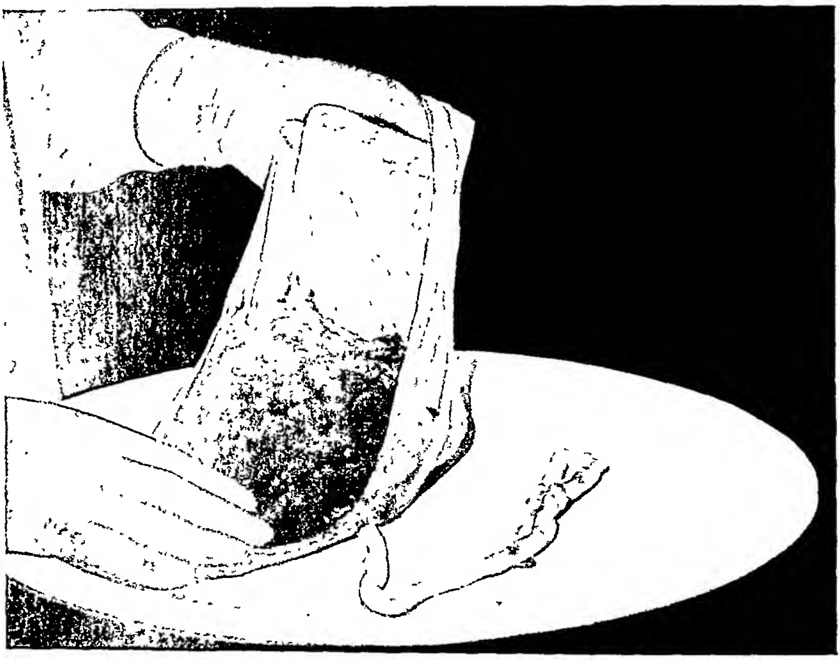

Fig. 446.—Inspection of the placenta. The placenta should be spread out on a flat surface, maternal side up. All blood clots must be gently wiped away. To expose the fetal surface the placenta should be lifted by the cord. This permits of careful and complete inspection of the placenta and membranes without the risk of producing artifacts or of overlooking any defects.

it is proper under strict aseptic precautions to expose the cervix to permit of traction on the membranes which may be accessible at the external os. If the retained membrane is wholly chorion it will disintegrate and come away unobserved in the lochia. The smooth resistant amnion, however, remains intact and is discharged usually some time during the first week of the puerperium, during which there may have been a foul odor indicating a saprophytic type of infection with or without low-grade fever.

Traction on the cord to accomplish delivery of the placenta carries with it the risk of inversion of the uterus if any portion of the placenta remains firmly attached. This method of delivery of the placenta has long since been discarded because of the danger involved.

has been the stepchild of even the finest medical schools, for it must be realized that the physician in general practice will continue to serve as an obstetrician for many years to come. It is only by giving him the opportunity first to thoroughly ground himself in the principles and practice of obstetrics in his student days, then to improve himself within the limits of institutional internship which should include an obstetrical service, and lastly to give him postgraduate opportunities that he can keep abreast of the occasional but real advances in the art and practice of obstetrics.

The relationship between the patient and her obstetrician includes the intangible but extremely important element of confidence which undoubtedly plays a major rôle in the control of the patient. This personal element should never be eliminated in the practice of obstetrics. Its lack is one of the shortcomings in the institutional type of obstetrical care which the future must strive to correct.

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contour suggests the possibility of the presence of clots or placental remnants in the uterine cavity.

In many instances, especially in women whose abdominal walls are thin and relaxed, irregularities in the outline of the uterine body may be felt and small subserous fibroids may easily be recognized. The round ligaments may also in some cases be felt.

The well-contracted empty uterus is felt as a rounded firm mass, the consistency being that of the well-contracted biceps muscle. After a time the palpating hand will note definite variations in the tonus of the uterine muscle. The uterine musculature contracts and relaxes, the interval between contractions varying in different women. There is a difference in the force

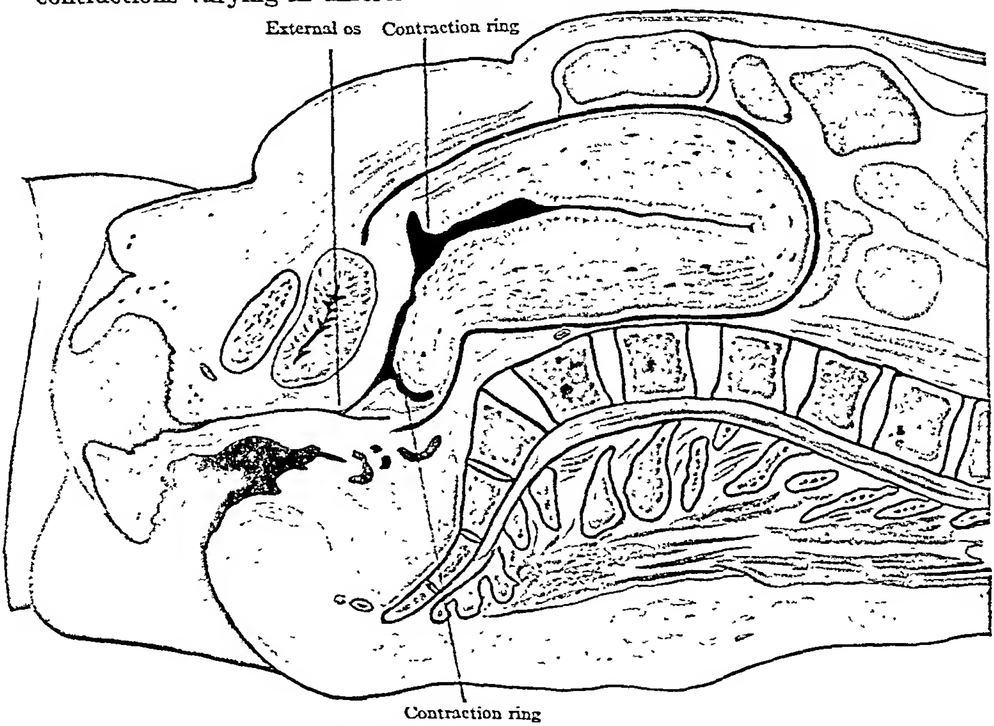


Fig. 447.—Frozen section of a primipara who died one hour after delivery, from hemorrhage and fatty heart. (Stratz.)

of these contractions in primiparae and multiparae, the variation between relaxation and contraction being much more marked in the latter. They are in some cases sufficiently forceful that they cause pain. This has given rise to the term "after-pains." The interval of time between them increases and they gradually disappear.

As the puerperium progresses the uterus becomes smaller. In a normal puerperium a daily decrease in its height and breadth may be observed. After twelve to fourteen days the fundus is no longer to be felt above the symphysis. Some text-books put the time of its disappearance at the tenth day. In the experience of the author this does not appear to be true in the majority of cases, in which a little longer time is required. That the uterus in fact disappears entirely behind the symphysis is scarcely correct as the fundus

the protoplasm of the muscle cells. The individual cells undergo a marked diminution in size. Sänger[32] showed that the muscle fibers, which after labor were 171 μ long and $11\frac{1}{2}$ μ wide, decreased in size by the fifty-fifth day to a length of $17\frac{1}{2}$ μ and a breadth of $4\frac{1}{2}$ μ. He found fatty degeneration in the muscle fibers and also a partial resorption of muscle tissue which had not

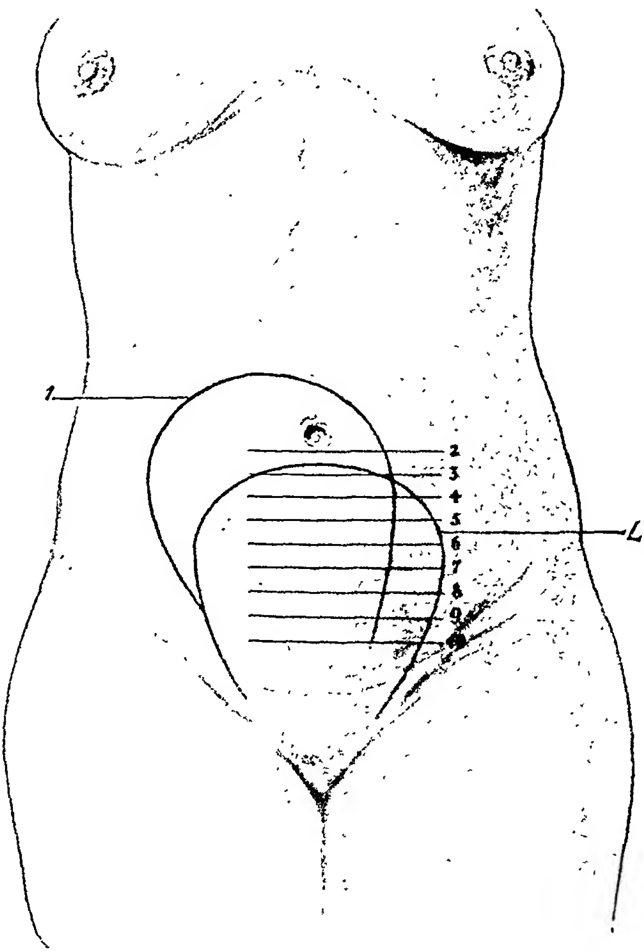


Fig. 449.—Height of uterus postpartum. Bladder empty. *L*, After labor: 1, First day; 2, second day, etc. (DeLee, "Principles of Obstetrics.")

undergone fatty degeneration. Broers[2] found in guinea-pig uteri no actual destruction of muscle cells but merely a reduction in size. Broers believed that the reduction in size was due at first to the throwing off of masses of glycogen, and, later, in part to a fatty degeneration. An autolysis occurs, the end-products of which are eliminated in the urine. Slemons[35] has shown that the increase in the nitrogenous urinary output at this time practically

This process has been described by Wormser.[40] The portion of the spongiosa which is not to remain is cast off within four to five days after delivery. The process advances more rapidly in some areas of the uterus than in others.

After the separation of that layer of the decidua which is to be cast off has been completed the regeneration of the epithelial covering of the uterine cavity begins. The new epithelial covering is formed by outgrowth of endo-

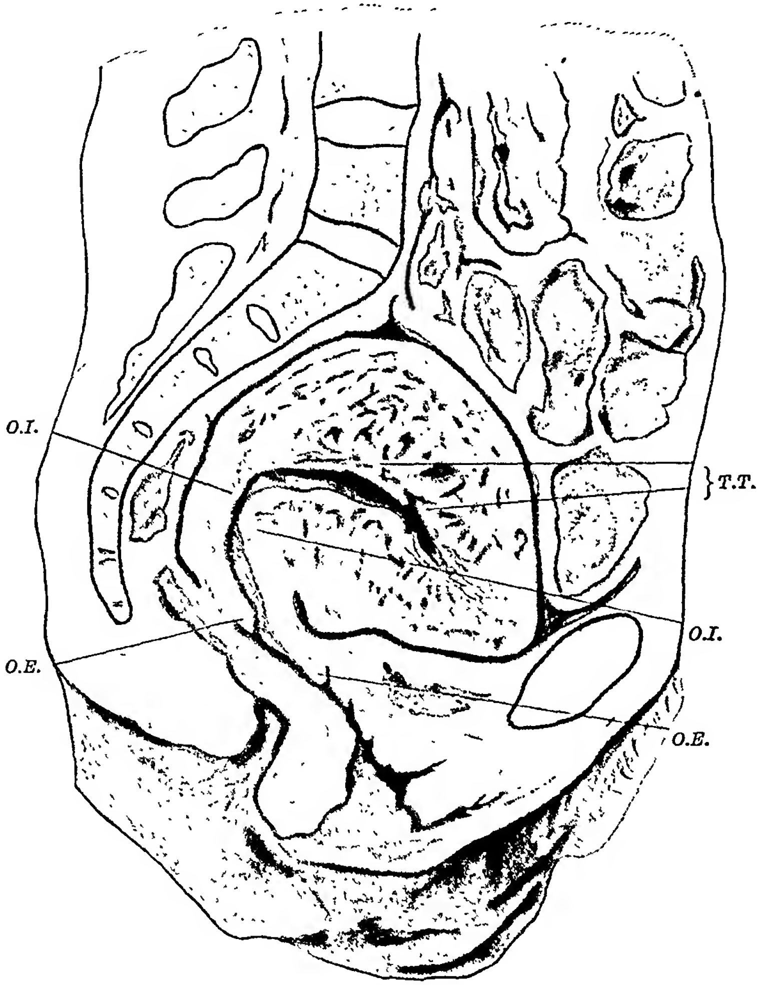


Fig. 451.—Uterus on fifth day postpartum. Redrawn from Bumm. After a frozen section in the Basle Clinic. Os internum closed. External os and cervical canal gaping. *O.I.*, os internum; *O.E.*, os externum; *T.T.*, thrombi at the placental site.

metrium from the fundi of the glands, the deeper portions of which are left in the layer of decidua which remains. The denuded areas, also, are constantly decreasing in size as the uterus continues to contract. The establishment of a new epithelial covering is, in most cases, nearing or has already attained completion in a week (Linnert[26]).

At the placental site these changes are more extensive than elsewhere. Here are the openings of the uteroplacental vessels which are filled with clots.

yellowish secretion known as *colostrum*. The breast is formed of a number of lobes, from 15 to 20 or more, arranged radially, and each lobe is divided into lobules. The lobules in turn are formed of acini of which a large number are present in each lobule. The actual formation of milk occurs in the epithelial lining of the acini. Each lobule possesses a small duct which unites with similar ducts from other lobules forming a single duct for each lobe. These ducts, the *lactiferous ducts*, open separately upon the surface of the nipple.

Jung,[21] in Döderlein's Handbuch, gives the composition of human milk, following the work of Engel, as follows:

		Per cent
	Water	86–87
Solids	Albumin	1
13–14	Fat	4–5
per cent	Sugar	7
	Salts	0.2

The albumin is divided into casein, lactalbumin, and globulin. According to Engel half of the bulk of the albumin is made up of casein and the remainder of lactalbumin and globulin. The casein of human milk differs from that of cow's milk in its much greater solubility in the digestive juices.

The fat is held in the fluid of the milk in tiny droplets, forming an emulsion. Their diameter is about 1 to 2 μ. The droplets do not coalesce. The fluid portion of the milk, or milk plasma, also holds the sugar and salts in solution.

The specific gravity of human milk is about 1030 and the boiling point about 100 C. Boiling does not coagulate the albumin but exposure to the air does. After standing a thick yellow layer of fat appears on the surface of milk. Human milk becomes sour as a result of bacterial activity.

No notable change occurs in the breasts during the first two days after labor. The secretion of colostrum continues. On the third and, in some women, on the fourth day, the breasts enlarge greatly. They become firm, sometimes quite hard and in some instances painful. This is a physiologic engorgement and does not mean that the breasts are distended with milk. Occasionally the enlargement may extend into the axilla of one or both sides, a firm and sometimes tender mass being felt. This is merely an extension of the glandular structure of the breast. The enlargement of this structure disappears of itself, its distance from the nipple precluding its being emptied and hence continuing to function. The congestion of the breasts decreases after two or three days. While the discomfort is greatest, the application of dry heat, as hot-water bags or electric pads, may give comfort. It was formerly believed that the establishment of milk secretion was accompanied by fever. The onset of puerperal fever on the third or fourth day, at about the time the changes in the breasts alluded to above occurred, gave rise to the belief that the congestion of the breasts caused the fever, hence the term "milk fever." There is no inflammatory factor involved in the swelling of the breasts in spite of the sensation of heat which the woman may have and which may be noted by the examining hand. A moderate acceleration of the pulse rate may occur and possibly a slight increase of temperature, perhaps to 99 F., but nothing further.

The amount of milk which is secreted varies widely. Women with very large pendulous breasts are, as a rule, poor producers of milk. The breasts

milk obtained last, or the "strippings," being richer. This fact should be kept in mind when an analysis of the milk is made. An analysis, in any event, has little value. In the author's service, in which all matters pertaining to infants are cared for by pediatricians, it was given up years ago.

Some drugs are known to be excreted in the milk. This is particularly true of cathartics which should be used with care. Opium and its alkaloids may also affect the child. Lead, iodine, arsenic, mercury, and iron may also appear in the milk.

During nursing, particularly if the breasts are not well drained, lactose may appear in the urine. It may be differentiated from the sugar of a true diabetes by a simple fermentation test or by the polarimeter. Its appearance need cause no anxiety. Nursing apparently favors a normal involution of the uterus, the stimulation of the breast by the infant causing the uterus to contract.

Abundant pediatric opinion supports the statement that the breast-fed infant possesses a distinct advantage over those which are fed artificially. This advantage is not wholly a nutritional one, the breast-fed infants apparently having a greater resistance to infection than others. Vitamins and antibodies are supplied by the mother's milk to a degree which it is impossible to equal artificially. Normal nursing is to the advantage of both mother and child.

The Resumption of Activity during the Puerperium.—Immediately after labor the mother may be allowed to lie upon either side or upon her back as she may prefer. She should not sit up, although after easy labors some multiparae are controlled with difficulty. Upon the third day she may be permitted to sit up for part of the day with the aid of a back rest. The variation of position increases comfort and raising the body facilitates drainage. As the axis of the vagina, when in the prone dorsal position, inclines toward the spine, the lochia tends to collect at the upper portion of the vaginal cavity. Raising the body aids in draining this lochial pool. Upon the third day the puerpera may also be asked to lie upon her face for a portion of each day. This may be done for a minimum of thirty minutes at a time, twice daily, or for as much longer as the patient herself may desire. Not infrequently mothers will prefer to sleep upon their faces and this they may be encouraged to do unless the engorgement of the breasts renders this position uncomfortable. When this occurs the face position may be deferred a day or two. In the face position the force of gravity may operate during at least a part of the time to cause the uterus to fall forward instead of constantly being pulled in the opposite direction. It is thought that this lessens somewhat the likelihood of posterior displacement.

Upon the sixth day, if progress has been satisfactory, the mother may be lifted into a wheel chair in which she should recline. During the warm seasons of the year she is taken out-of-doors. In our own service patients are taken to the sheltered roof of the hospital or upon one of its balconies. The length of time in the wheel chair varies with the strength of the individual woman and the period of the puerperium.

Upon the tenth day the mother is permitted to leave her bed for part of the day and to sit in a chair. On the eleventh she may walk a little in the hospital corridor and on the twelfth day, as a rule, she goes home. Upon the day of discharge a pelvic examination is made to ascertain whether the

At the end of six or eight weeks a final examination should be made. At this time the obstetrician ascertains whether involution is complete, the character of healing of vaginal injuries and whether any notable relaxations remain. The cervix should at this time be carefully inspected for the results of injury. If a marked ectropion exists it may be lessened and the resulting leukorrheal discharge diminished by treatment with the fine tipped cautery. This should not be used too deeply nor too high in the cervical canal and the linear stripes in the everted area should not be made too deeply. Cauterization should not be repeated too soon, at least a month being allowed to elapse before repetition. The use of the cautery is a valuable addition to our therapeutic resources during the puerperium but it should be remembered that it is a procedure the results of which are slow in appearing and that it may easily be overdone. A judicious use of the cautery at this time may decrease to a considerable degree the amount of permanent cervical damage. The details of cautery treatment of cervical lesions will be found in Dickinson's[10] paper.

Upon the discharge of the mother from the hospital, which ordinarily occurs about the twelfth day, or at the time she begins to get up if she has been confined at home, she should be carefully instructed as to her activity during the remainder of the puerperium.

During the third week of the puerperium she should remain on one floor, being advised to lie down one half of the time. Stairs are not especially harmful, the end sought in restricting the mother to one floor being attained by the fact that in a limited space her movements tend automatically to restrict themselves. It is very difficult, if a woman gets downstairs, to keep her from taking up too many of the household responsibilities. During the fourth week of the puerperium she may be permitted to go downstairs once a day and at the end of the fourth week she may begin to go out a little, riding and walking short distances which may gradually be increased. Full activity should not be resumed until eight weeks have elapsed, and the mother, at the end of this period, may find that she still fatigues easily. Tub baths may be taken at the end of three weeks and showers immediately upon leaving the bed. It is realized that for economic reasons many women cannot carry out so conservative a program but whenever it is practicable the conduct of the puerperium should be based on the physiologic fact that the return of the reproductive tract to the normal nongravid state requires at least eight weeks.

Care of the Breasts.—The prevention of infection of the breasts resolves itself into nothing more nor less than an exaggerated degree of cleanliness. Before and after nursing the nipples should be gently cleansed with a solution of boric acid. Between nursings the nipples are covered by small squares of dry sterile gauze which is held in place by a breast binder.

A number of thicknesses of gauze will be needed to absorb the milk which in many cases runs from the nipples. A very satisfactory nipple pad is made of a square of cellotex or other absorbent material covered with gauze.

It is quite impossible to sterilize either the skin of the nipple or the mucosa of the infant's mouth and complete cleanliness is the chief reliance against mastitis. Between nursings it is well for the nipple to be kept dry if possible in order that maceration may be minimized. The formation of cracks is thus rendered less likely.

influences the process at all, and both serve only to reduce discomfort, the preferences of the woman may be followed. The author has followed this very conservative plan for many years and is quite convinced of its superiority to older and more meddlesome methods.

Temperature during the Puerperium.—While it might be assumed that under ideal conditions the puerperium should be wholly fever-free, practically this does not always occur. There are nearly always wounds of greater or less extent in the birth canal, and this is particularly the case with primiparae. Bacteria are always present in the genital tract, and, after the first two days of the puerperium, they are found in the lower uterine segment. The conditions which favor bacterial invasion are therefore always present. The infrequency of sepsis in properly conducted cases is probably to be ascribed to the relatively harmless character of the normal vaginal flora, the rapidity with which the inner surface of the uterus is protected by the normal process of healing, aided by the contraction of the uterine musculature, and to the excellent drainage of the reproductive tract. While these factors confer a high degree of safety if virulent bacteria have not been introduced from without, it cannot be said that even under ideal conditions infection may never occur. The author has seen a case, under the care of an associate, of a multipara who had a normal, rapid, spontaneous delivery, with no vaginal examination, and with a spontaneous rupture of the bag of waters, and with no visible birth injury, in which fatal sepsis occurred. It is probable that this woman harbored virulent streptococci in her cervix or vaginal vault. Goodall[15] has drawn attention to the potential pathogenicity of bacteria in the cervix in parturient women.

Some confusion exists as to the standard by which puerperal morbidity shall be judged. Reports in the literature are based upon varying criteria and this leads to difficulty in comparisons. From a practical point of view it would seem that the standard recommended by the American College of Surgeons is entirely satisfactory. This rule classes as morbid all women who show a temperature of 100.4 F. (38 C.) or more on two consecutive days excluding the first, and before the tenth day. This agrees with the standard of morbidity set by the British Medical Association.

A study by R. M. Grier[16] of 562 consecutive cases upon one floor in the author's service showed that 76 women showed a temperature of 100.4 F. or more at some time and that 27, or 4.8 per cent, could be considered as febrile by the standard given above. Those whose temperatures rose to 100.4 F. for a part of one day only were 8.7 per cent of the total number.

Of the clinical observations made during pregnancy the temperature reading is probably the most important. Any rise of temperature beyond the limits stated above should arouse the interest of the physician. Indeed, the very slight temperature rise admitted in the standard given must itself be due to slight degrees of infection. The standard merely attempts to draw a line between those cases which may be regarded as safe and those which must be more carefully studied.

The absence of any relationship between the beginning of lactation and fever should be emphasized. There is no such clinical entity as "milk fever." A rise of temperature should not be ascribed to constipation. It is possible that a greatly overloaded lower bowel may cause enough obstruction to lochial drainage as to cause a low fever but the author doubts that constipa-

upon the face vanishes or at least greatly lessens. The pigmentation of the nipples remains to some degree, the nipple nearly always being somewhat darker than before. The greatly enlarged areola shrinks to its normal size and the pigmentation of the remainder of the breast disappears. The bluish color of the stiae gravidarum, if any are present, pales and the striae approach the color of the surrounding skin. The marked pigmentation of the external genitalia also greatly lessens.

The Urinary Tract.—Immediately after delivery cystoscopic examination will show bruising which has resulted from the pressure of the advancing fetal head. Edema and small submucous hemorrhages may be seen in the trigonum. The swelling and discoloration, after difficult deliveries, may be sufficient to obscure the ureteral orifices. Injury to the vesicovaginal septum may allow the base of the bladder to sink. When this is the case cystocele appears later.

The urine secured immediately after delivery frequently contains a trace of albumin, a few leukocytes and occasionally red cells. A few cylindroids may perhaps be seen. These disappear as a rule within a few days. Lactose is frequently found in the urine of puerperal women. It is often present during the early days of lactation when the breasts are engorged and again appears when lactation ceases, particularly if nursing is stopped while the breasts are functioning actively. It is least frequently found when nursing is being normally carried on and the breasts are not engorged. It is physiologic and need cause no anxiety.

The amount of urine is notably increased during the puerperium and a marked increase takes place in the nitrogen content. This has already been alluded to in discussing the changes incident to involution of the uterus. The average specific gravity is 1018 to 1020. A daily output of 1500 cc. or more is not infrequent. The amount of urine excreted during labor is diminished especially if the labor is difficult or prolonged.

The bladder during the latter weeks of pregnancy is pushed forward by the pregnant uterus and during labor is drawn upward by the retraction of the cervix and lower uterine segment. After delivery the bladder returns to its normal location in the true pelvis. The position of the puerperal uterus may be influenced by the variations in size of the uterus as it fills and empties. The bladder after delivery has much more space and the feeling of desire to urinate which was experienced before delivery is relieved.

It is a clinical fact of importance that the bladder may contain large amounts of urine without discomfort. In this the bladder during the puerperium varies distinctly from the bladder after operation as the latter is painful when distended. The author has repeatedly seen 1000 to 1500 cc. of urine evacuated from the bladder by catheter without the patient having complained of any pain. The bladder should not be permitted to distend to this degree, and with attention it need not occur, for long before so large an amount of urine has accumulated a fluctuant mass will be palpable over the symphysis.

The inability to void, which is frequently seen in the puerperium, is probable largely due to the trauma received by the base of the bladder and the urethra which leads to a temporary inhibition of function of the vesical innervation. The degree of trauma to which the bladder and urethra are subjected depends upon the character of the labor, the severity of any opera-

obtained and in 3 both colon bacillus and staphylococcus appeared. Thirteen gave no growth. In 14 additional cases more extended bacteriological study was made, cultures being made on agar slants, in agar and ascitic fluid, and anaerobic cultures in agar to which goat's blood had been added. In these 14 cases staphylococci were found seven times and in 1 case the pseudodiphtheria bacillus was found. Bacteria are therefore frequently present in the bladders of apparently perfectly healthy gravidae, and they, together with the presence of a pool of unevacuated urine, produce a condition from which cystitis may easily result. The regular removal of the residual urine, with careful asepsis, reduces materially the likelihood of bladder infection. The withdrawal of the urine by the catheter should be followed by the instillation of 15 cc. of 0.5 per cent solution of mercurochrome or 0.25 per cent $AgNO_3$.

As a rule in puerperal women a glass catheter is more satisfactory than a rubber one. During labor a glass catheter must never be used. If catheterization is to be done by an inexperienced person a rubber catheter is safer as it permits less trauma. When an experienced person is to carry out the procedure, the glass instrument is to be preferred. It may be held by one end while the opposite extremity is introduced into the urethra. Contamination by touch is thus minimized. Sufficient light and exposure are essential.

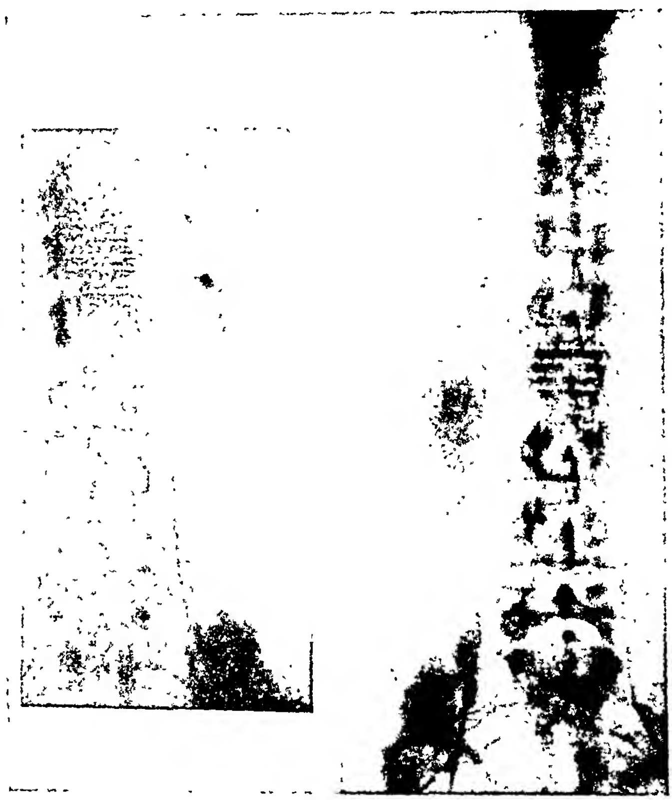
Urinary Complications.—Far less commonly than inability to void is seen an incontinence of urine. This is caused by injury to the base of the bladder, the urethra and the sphincter vesicae, the latter having been stretched or its fibers divulsed. This condition usually accompanies injury to the anterior vaginal wall. It is usually not complete, only a partial lack of bladder control being present. This may lead to expulsion of small amounts of urine upon coughing, sneezing or when any sudden contraction of the abdominal muscles takes place. It is usually temporary and passes off as the effects of birth trauma disappear. In some cases it may be permanent, and in these the only relief lies in plastic surgery later.

Urinary fistulae resulting from birth injury and their treatment will be discussed elsewhere.

Cystitis may appear during the puerperium. It may be a continuation of an infection which was present during pregnancy or be caused by infection of the bladder during or after delivery. Failure of the bladder to function properly during the early days of the puerperium is the most frequent cause. If not severe it may be allowed to subside spontaneously, water being given freely to cause a free flow of urine. Drugs are of little value. Alkalies, such as sodium citrate or sodium bicarbonate, are as effective as any. If the condition is severe, or persistent, lavage of the bladder with boric acid solution or a solution of normal salt followed by instillation of a weak antiseptic solution is of value. Mercurochrome in a strength of 0.5 per cent may be used, about 15 cc. being left in the bladder. If the infection is confined to the bladder, it will usually disappear spontaneously or after a few instillations. If the cystitis does not promptly improve, the possibility of infection at a higher level of the urinary tract must be considered.

Pyelitis may occur during the puerperium and may be an infection beginning at that time or a recurrence or continuation of a pyelitis which was present during pregnancy. While the pyelitis of pregnancy usually disap-

the lower portion of the uterus caused by advanced pregnancy. Whether either of these explanations may be established as the actual cause of urinary obstruction is of academic rather than clinical importance as either is relieved by the termination of pregnancy. If no intrinsic damage to the structure of the ureter has taken place, normal renal drainage is reestablished. In some cases, in which severe infection has been present during pregnancy, actual damage to the ureter itself may remain and cause later interference with urinary drainage. This was found in several of the cases studied by Corbus and the author.[5] Recovery can only be brought about by the re-



A *B*

Fig. 457.—*A*, Four months after abortion. Early hydronephrosis, ureteral kink, hydro-ureter, and stricture at ostium. *B*, Six months after delivery. Hydronephrosis, ureteral kink, hydro-ureter, and ureteral stricture. (Corbus and Danforth.)

establishment of the normal flow through the ureter. This may require repeated dilatations of the ureter. It should not be assumed that disappearance of pain and fever after the uterus is emptied indicates that the urinary tract has invariably returned completely to normal. The management of these cases constitutes a urological problem.

Pregnancy, and particularly repeated pregnancies, especially in slender women of the long-waisted type, exercises a definite influence in the production of movable kidney. This does not produce a complication of the puerperium and need not be discussed here.

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SECTION VI

CHAPTER XXVI

THE NEWBORN CHILD

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There is no period of life so full of significant physiologic and anatomic changes as that of the transition from intra-uterine to extra-uterine life. This is known as the newborn period. The time required for the organism to make its new adjustments varies somewhat with each individual. As a rule it is about two weeks, or roughly the time required for the average infant to regain its birth weight, this being a fairly reliable indication that a physiologic equilibrium has been attained.

ANATOMIC AND PHYSIOLOGIC PECULIARITIES

The newborn child has certain anatomic and physiologic peculiarities which must be known, for intelligent management of the infant during this period is dependent upon such knowledge.

Many sudden and profound changes take place when birth necessitates an immediate assumption of life independent of the maternal organism. The changes in the various organ systems will be discussed separately for the sake of clarity, although there is, of course, a close interrelationship of nearly all the systems.

I. Respiratory System.—Initiation of respiration is brought about through the stimulation of the respiratory centers by the increased carbon dioxide in the blood following the interference with the placental circulation during labor and its final cessation after birth. Respiratory effort usually occurs almost immediately upon the birth of the child and is soon followed by more or less lusty crying. Inflation of the lung alveoli thus produced and the accompanying establishment of the pulmonary circulation bring into function the new mechanism for gaseous exchange. The respiration is almost entirely diaphragmatic at first, is rapid, rather shallow, and of irregular rhythm.

1. *Atelectasis.*—Normally, the alveoli are inflated throughout most of the lung within a short time, although there are often small areas where inflation is not complete for several hours or even days. These atelectatic areas are usually in the region of the hilus and along the vertebral margins of the lungs. This condition causes no trouble and is spontaneously overcome in a short time. Under certain circumstances, however, as for example when a main bronchus becomes obstructed by aspirated mucus or amniotic fluid, or where respirations are feeble as in the case of premature infants, large areas of lung may remain uninflated. In such cases atelectasis becomes serious.

heat-producing tissue. The importance of a warm delivery room and the avoidance of prolonged exposure is thus evident.

IV. The Blood.—The important peculiarities of the blood of the newborn may be briefly summarized as follows: The hemoglobin percentage is high (105–120 per cent) in the first days, but falls rather rapidly; by the second to the third week it reaches the figures considered average for later infancy (70–80 per cent). The number of erythrocytes is also high, averaging from 5,500,000 to 6,000,000 per cubic millimeter. These figures also fall to a level approximating that of later infancy (4,500,000–5,000,000) by the second to the third week. The leukocytes are much more numerous than in the adult, averaging 18,000 to 19,000 per cubic millimeter at birth and falling to 9000 to 10,000 by the fourth to fifth day, after which there is a gradual increase to 11,000 to 12,000 by the end of the second week. The polymorphonuclear cells predominate at first but decline during the first ten days, while the lymphocytes increase so that by the end of the newborn period the latter are definitely more numerous. The coagulation and bleeding time increase perceptibly in the third, fourth and fifth days, corresponding to the time when hemorrhagic disease usually occurs. Just what factors are responsible is still undecided. Sanford,[1] as a result of recent studies, holds that the hemorrhagic tendency in the newborn must be due to some factor other than those factors known to be directly concerned with coagulation. Probably all newborn infants have bilirubinemia; the amount of bilirubin varies in individual instances, but tends to increase up to the third day and then rapidly drops to normal. The bilirubin content of the blood probably has a definite bearing upon icterus neonatorum.

Icterus Neonatorum.—This subject has received a great deal of attention, and deserves a brief discussion here. Probably there are very few infants that do not have some degree of icterus, but it can easily be missed in the milder cases unless very carefully looked for. It first makes its appearance on the second or third day, and may last but a day or two. In some cases, its appearance is delayed until the fourth or fifth day. It may be very intense, and persist until well into the second week, or, in spite of its intensity, disappear in a few days. There seems to be no parallelism between the intensity and the duration of the icterus. The duration is usually longer in premature infants. The general condition of most infants is influenced very little, if at all, by icterus neonatorum; some are more sleepy and less inclined to nurse, and may even show a more marked loss in weight than would be expected considering a fairly normal food and fluid intake.

The etiology of this condition has been the subject of much controversy, and it is still unsettled. A short etiologic summary only will be given here. All newborn infants have an increased bilirubin content in the blood. This bilirubinemia is due to an increased disintegration of erythrocytes. At birth, the hemoglobin content of the blood and the number of erythrocytes is high, because the relative oxygen poverty existing before birth had to be compensated for in this way. After birth there is sufficient oxygen, this excess is no longer necessary, and the superfluous erythrocytes disintegrate. In addition to this extensive disintegration immediately after birth, there continues to be a relatively large "turnover" of erythrocytes for several days because of an increased activity of the hemapoietic organs, possibly due to the increased congestion which accompanies birth. The result is that there

more often in the urine of infants born of eclamptic or preeclamptic mothers. It is, however, an entirely physiologic phenomenon in the majority of cases.

VII. **Genital Organs.**—The scrotum varies greatly in size in different male infants; the testicles are usually to be found in the scrotum. Not uncommonly one or both testes may be in the inguinal canal, but can, as a rule, be easily forced into the scrotum. In comparison to their adult size the testicles are proportionately smaller than are the ovaries, a fact that is attributed to the apparent predominance of the female sex hormone in newborn vertebrates. The prepuce usually extends well over the glans and at its end has a very small opening which is usually adequate for the free passage of urine. In rare instances it may be necessary to gently dilate the preputial orifice. Emergency circumcisions and dorsal slit operations are unnecessary and meddlesome procedures. In the female the labia majora are full and in contact or only slightly gaping, so that the labia minora and clitoris are hidden or show but slightly. However, there are great individual variations. In premature infants it is more common to see prominent labia minora and clitoris. A grayish-pink fleshy tag often protrudes from the posterior angle of the vulva, the *hymenal tag*. At times one finds instead a cyst, pea-sized or larger which, when it ruptures or is incised, discharges a viscid grayish mucus, such as one normally sees exuding from the vagina in the first days of life; this is a *hymenal cyst*. Hemorrhage from the vaginal opening will be discussed under pregnancy reactions.

VIII. **Endocrine Glands.**—*Thymus.*—The size and shape of the thymus varies greatly in normal newborn infants. Roentgen examinations of infants during the newborn period seem to show a thymic shadow larger than normal in from 40 to 50 per cent.

Thyroid.—The size is variable but as a rule it is relatively large, weighing from 1.6 to 2.8 Gm. Much higher average weights have been found in goitrous regions. The isthmus of the gland usually covers the second, third, and fourth rings of the trachea. It is practically impossible to determine the functional activity of the thyroid at birth because of the presence of thyroid hormone from the maternal circulation during intra-uterine life.

IX. **The Nervous System.**—The brain is relatively large and incompletely differentiated. The motor cortex is less sensitive to stimulation than in later infancy and coordination is not well developed. The tendon reflexes can usually be obtained but are as a rule less pronounced than at a later period. The superficial reflexes are sometimes elicited, but with difficulty, and are very often absent. The reaction obtained by stroking the sole of the foot is variable; some observers report a high percentage of dorsal flexion of the great toe, while others claim to have obtained a much higher percentage of plantar flexion.

PHYSICAL CHARACTERISTICS OF THE NEWBORN CHILD

The normal newborn child assumes a flexed position, the posture corresponding in general to its intra-uterine attitude. The arms are flexed at the elbows and lie against the chest, the hands are closed. The lower extremities are partially flexed and abducted and the feet inverted and dorsally flexed, so that the dorsum of the foot can easily be pressed against the anterior surface of the leg. The size of the newborn child is influenced by many factors—

those on the affected side are brought together. This deformity may persist for weeks or months but finally disappears spontaneously. When the pressure of the shoulder is exerted against the region posterior to the ear it may injure the facial nerve as it emerges from the stylomastoid foramen. A few cases of facial paralysis following spontaneous birth have been ascribed to this cause.[3]

Most infants at birth are bowlegged. The deformity is doubtless due to the folded position of the legs during intra-uterine life. However, in certain breech presentations the legs are unusually straight or may be dissimilar in contour; one showing a definite knock-knee deformity while the other is either straight or bowed. The thorax also frequently shows the effects of intra-uterine posture. The upper arms pressed firmly against the thorax cause flattening of the lateral chest walls, sometimes to a considerable degree. Accompanying this there is often sharp angulation of the ribs at the costochondral junction, now and then erroneously interpreted as rachitic beading.

Pes calcaneus, which in some degree is present in a great majority of newborn infants, is still another deformity due to conditions of intra-uterine posture. Extreme and prolonged dorsiflexion of the foot relaxes and stretches the tendon of Achilles. Unless there is at the same time marked inversion or eversion of the foot the deformity disappears spontaneously. But when the foot is in a varus or valgus position passive movements and massage are advisable, and the help of an orthopedist should be sought if the deformity is great.

Petechial hemorrhages on various parts of the body surface, due to the general venous stasis and consequent capillary congestion resulting from birth, are not uncommon. On the face, particularly the forehead, these petechiae are most often seen. In the mucous membranes, too, such hemorrhages occur, and they are often found in various internal organs at autopsy even after a perfectly normal labor. Subconjunctival hemorrhages along the margin of the cornea are frequently seen and several clinicians have found by ophthalmoscopic examination that retinal hemorrhages are not uncommon.

THE RESULTS OR SUBSEQUENT EFFECTS UPON THE NEWBORN OF ITS FETAL LIFE

The newborn period in a broad sense may be said to continue over a much longer period than the ten to fourteen days commonly given as its limit. Certain biochemical peculiarities of the newborn organism resulting from its intra-uterine life cause it to react to its new environment in a unique way, and also result in unique physical and physiologic changes. The most important of these will be briefly discussed.

The water content of the tissues is higher than in later infancy, and premature infants have an even higher percentage of water than do infants born at term. The full term infant is usually well supplied with subcutaneous fat, most of which is deposited in the last three months of fetal life, and particularly in the last month. The weight of the infant at birth is largely dependent upon the water content and upon the amount of fat deposited during fetal life. Initial weight loss results from loss of water as urine, in the stools, and by insensible perspiration. And the rather rapid regaining of the lost weight is probably due to the unusual ability of the tissues to absorb water.

On one or both cheeks, as the result of pressure from the forceps blades, and on other parts of the body, especially on the back in the scapular region and on the buttocks, one not infrequently finds firm indurations in the subcutaneous tissues due to pressure from the fingers of the attendant as he grasps the baby with unusual firmness or spanks it to stimulate respirations. This condition has until recently been classified as scleroderma neonatorum, but since the pathology has been shown to consist of necrotic changes in the subcutaneous fatty tissues it is now rather generally being more accurately referred to as *subcutaneous fat necrosis of the newborn*. The areas of induration are quite firm and vary from small button-like areas of induration the size of a dime to rather extensive plaques the size of a dollar or larger. The overlying skin may show no discoloration or may have a faintly purple color. Spontaneous subsidence of the induration usually takes place in from two to three months. I have twice seen areas of subcutaneous fat necrosis become infected. In each case signs of infection were first noticed in the second week, the overlying skin became reddened and the inflammation spread rapidly, leading to extensive suppuration. When incisions were made for drainage it was found that suppuration was limited to the subcutaneous fatty tissue, making an extensive but shallow abscess cavity, the floor of which was the superficial fascia, and the roof the skin itself. The affected area was on the back in both cases, in one the interscapular region and in the other the lumbar region. Recovery after several weeks of illness occurred in both instances without necrosis of the overlying skin.

Of birth injuries affecting the muscles, hematoma of the sternocleidomastoid is the only one of sufficient practical significance to demand discussion. While it may occur in cephalic deliveries it is more common as a result of breech deliveries in which the muscles of the neck are more liable to trauma and stretching during delivery of the head. As a rule nothing unusual is noted until the second week or later, when a hard hazel nut-sized or slightly larger tumor is discovered in the muscle, usually at about the junction of the lower with the middle one third. It is frequently discovered accidentally by the mother, for there are often no other symptoms, but sometimes a tendency of the child to incline its head toward one side and tilt the face upward toward the opposite side leads to the discovery of the injury. The tumor, when discovered, is usually of cartilaginous hardness and only slightly tender to pressure. It is due to hemorrhage into the muscle with subsequent myositis and, finally, fibrous organization of the clot. After a few months it is as a rule no longer palpable. The wryneck deformity if present is temporary in most cases, and this injury is no longer considered an important etiologic factor in congenital torticollis.

Peripheral Nerve Injuries.—The most common of the peripheral nerve injuries is that affecting the facial nerve. Trauma to the nerve from the pressure of forceps blades at or near its point of emergence from the stylomastoid foramen is the commonest cause of *facial paralysis*. At times, however, it may result from compression in other obstetrical manipulations. Facial paralysis has occasionally been observed following spontaneous delivery and in such instances it has been assumed that the nerve has been injured by some protruding bony eminence of the pelvis. A few observers have called attention to the occurrence of facial paralysis in spontaneous deliveries where there has been lateroflexion of the head due to cramped intra-uterine

modified Velpeau bandage, or simply pinning the sleeve at the wrist to the front of the nightgown is the only treatment necessary, and even this is probably not essential.

The *humerus* is rarely fractured in vertex deliveries but this accident occurs with relative frequency in breech deliveries, and in version and extraction when bringing down the prolapsed arm. The obstetrician is usually aware that the fracture has occurred, and there is also deformity, crepitation, and evidence of pain to call attention to the injury. The site is usually the middle or upper one third. The amount of dislocation of the fragments is not great, as a rule.

Fracture of the *femur* is less frequent but of more practical importance than the other fractures mentioned. Here as a result of muscle pull there is greater displacement of the fragments and more difficulty is encountered in getting them in good position. This accident happens in extraction in breech presentations. The fracture is usually in the upper one half. Vertical suspension of the leg by means of weights and pulleys is the usual method of treatment.

The tendency toward spontaneous correction of deformities due to fractured bones in young infants can be relied upon to bring about a good end-result, even when appliances have failed to bring the fragments into good position. A great deformity may be scarcely perceptible at the end of the first year.

Linear fractures of the *cranial bones* may occur during birth even in spontaneous deliveries. But much more frequently the cranial bones show indentations due to pressure against bony prominences in the pelvis, particularly the promontory of the sacrum in flat pelves. The indentations usually appear as spoon-shaped or troughlike depressions in the lower anterior portion of the parietal bone or on the frontal bone near the coronal suture. Their significance is chiefly cosmetic. The milder forms disappear completely or almost completely in time, and the more severe ones unless on the forehead can usually be left alone. Corkscrew-like instruments have been devised to lift the depressed bone.

Cephalhematoma is the name given to tumors caused by effusions of blood under the periosteum of the cranial bones. There is tangential displacement of the soft parts including the periosteum of the cranial bones during labor. The forward and backward movement of the head against the fixed bony parts of the pelvis produced by uterine contractions and relaxations cause this displacement in a varying degree. In some instances the blood vessels are torn and the effusion of blood lifts the periosteum and strips it from the underlying bone. A fluctuating tumor varying in size from a walnut to an orange is thus formed. The usual site is the posterior portion of a parietal bone but is sometimes the occipital or frontal bone. Since the periosteum is firmly attached to the bone at the suture margin the effusion cannot extend beyond it. In some instances a cephalhematoma will develop on both parietal bones; since they stop abruptly at the bone margins the sagittal suture lies between them like a deep furrow, giving a grotesque appearance to the head. The tumor may develop very rapidly, even being demonstrable at birth, but ordinarily it is not recognized until the second day, after which it gradually increases in size until toward the end of the first week. Its early recognition

the mechanical forces exerted on the after-coming head are responsible for the rather frequent intracranial injuries that occur in this type of birth.

4. THE FRIABILITY OF THE BLOOD VESSELS AND THE VULNERABILITY OF THE BRAIN SUBSTANCE are factors particularly operative in the case of premature infants. Yllpö[5] has proved that the less mature the infant is at birth the less resistant are the blood vessel walls. In addition, the brain substance of premature infants is of such soft consistency that it offers little support to the blood vessels.

Familiarity with the great variety of factors involved is essential to an understanding of the occurrence of brain injuries under such varied circumstances. Thus we find them in protracted and in short labors, in spontaneous and in operative deliveries, in labors where the pains have been feeble as well as where they have been unusually strong, in cephalic and in breech presentations, in full-term and in premature infants. Even when delivery has been by cesarean section they are at times observed. And often the mechanism of the injuries cannot be explained from a single viewpoint; they must be looked upon as due to an interaction of a variety of factors.

Pathology.—For a detailed discussion of the pathology of intracranial injuries the reader is referred to text-books on diseases of infancy. The majority of these injuries are due to hemorrhage. Subdural hemorrhages arise from veins draining into the longitudinal sinus and from the tentorium, and are classified as supratentorial or infratentorial depending upon whether the effusion is into the anterior or the posterior cranial fossa. Leptomeningeal hemorrhages into the pia-arachnoid on the convexity and base of the cerebrum and cerebellum are quite common and sometimes very extensive. Then there are hemorrhages into the cerebral substance and into the ventricles, due chiefly to passive congestion in the veins that empty into the vena magna galeni.

Some intracranial injuries give rise to no demonstrable pathologic changes or at most only local edema. Such injuries are usually the result of direct trauma to the brain not causing hemorrhage but producing definite cerebral symptoms or even death. This we call *contusio cerebri.* It is also true that areas of softening and evidence of cerebral hemorrhage may be found in children dying in later infancy or in childhood who have at no time in their lives shown signs of cerebral lesions. In view of these opposing observations, *i. e.*, severe clinical symptoms without definite cerebral pathology and real pathologic findings without cerebral symptoms, it is necessary that we be cautious in the evaluation of small cerebral hemorrhages, tears in the tentorium without extensive effusion of blood, etc. Death may have been due to some other cause, but these lesions are evidence of the mechanical force to which the infant's head was exposed during birth, and indicate that the real cause of death, though not demonstrable, was probably due to birth trauma.

Symptoms.—In serious injury to the brain, as in massive hemorrhage over the cerebral convexities or below the tentorium, asphyxia is often a prominent symptom. Many die without recovering from this asphyxia; and then it is impossible to differentiate the asphyxia due to intracranial injury from ordinary asphyxia, without autopsy. If when resuscitated the child cries lustily, the asphyxia was probably not due to intracranial injury, for in that condition the first cry is not strong and later crying is more of a whimper than a real cry. Somnolence is a characteristic symptom in most cases and differs

The baby is usually allowed to nurse for twenty minutes. It is probably not wise to permit the baby to nurse longer as it has probably obtained all it wants or all it can get in that length of time and prolonging the nursing will only tire the baby without serving any useful purpose.

The average infant nursing on a four-hour schedule will, if lactation is well established, be getting from 2½ to 3½ ounces at each feeding by the end of the first or the beginning of the second week. But the amounts obtained at the different feedings are by no means uniform throughout the twenty-four hours. These fluctuations in the size of the individual feedings are probably due as much to variations in the eagerness the baby exhibits in nursing as to variations in the amount of milk available. At some feedings the baby is wide awake and hungry while at other times he is sleepy and not interested. It is also true that certain circumstances hinder the full functional activity of the mother's breasts, so that at some nursing periods she will have a larger supply than at other times. It is not possible to discuss this interesting question in the space permitted here; the reader is referred to text-books on pediatrics for information concerning the factors influencing breast-milk secretion. Here it is sufficient that we be reminded that the most important factors are the mechanical stimulation that the breasts get, the mental and general nervous equilibrium of the mother, and the mother's diet.

Anyone who has watched the weight curves of a large number of infants during the newborn period and has analyzed them with reference to the rate of gain in weight as compared to the amount of food ingested, will recognize how impossible it is to make a general statement regarding their food requirements. One infant weighing 8 pounds at birth will gain satisfactorily on 17 or 18 ounces of breast milk a day, while another apparently equally healthy infant with a birth weight of 7 pounds will gain less rapidly on 20 to 21 ounces a day. These differences are independent of the quality of the milk, at least as regards caloric value. It must be assumed that the discrepancy lies in the individual peculiarities of the infants' metabolism. A satisfactory gain in weight is a much more important consideration than keeping the food intake up to a certain amount, conforming to some arbitrarily established standard. Weighing the infant before and after nursing to determine the amount obtained from the breasts is a worthwhile procedure and is to be recommended wherever it can be carried out. It gives the physician valuable information regarding the functional capacity of the mother's breasts. But the figures thus obtained should not be used to determine how much artificial food to give as a complemental feeding in case the infant is not gaining properly. The practice in many obstetrical hospitals is to give enough of the complemental food to bring the total quantity of each feeding up to 3 ounces. In view of the lack of uniformity of relationship between gain in weight and amount of food intake such a practice seems too arbitrary; there will be many feedings when the infant would take more and also many when it is satisfied with less, just as is the case when the supply of breast milk is abundant. It would therefore seem more logical to offer those infants that are not gaining satisfactorily 2 ounces of complemental food after they have nursed at the breasts and allow them to take what they will of it regardless of the amount obtained at the breasts. If they are hungry they may take it all even though they have already obtained 2 ounces at the breast, and if they are not they may take very little or none at all. More

is much more often seen than overnutrition. It can usually be avoided if the weight curve is carefully watched and proper complemental feeding instituted at the right time. Failure to gain properly is seldom due to defective quality of the breast milk. If the baby is fed entirely or largely on artificial food he is subject to the same acute disturbances of nutrition that occur in later infancy. Artificial feeding during the early weeks of life is treacherous and should only be undertaken when absolutely unavoidable. Nutritional disturbances in the newborn may be due to infections either of the gastro-intestinal tract, or of any other part of the body, or as a part of the picture of a sepsis.

PATHOLOGIC CONDITIONS WITH PHYSIOLOGIC BASIS

The normal progress of the newborn may also be disturbed when certain symptoms considered physiologic assume pathologic proportions. Thus, the initial weight loss may be excessive, there may be an abnormal degree of dehydration and, as an accompanying condition, *transitory fever* sometimes occurs. As stated in discussing the question of giving artificial food in the very first days of life, these developments can generally be avoided if complemental feeding is started early (on the second day). A 5 per cent glucose solution in plain water, or in one half strength Ringer's solution will usually do the same thing. Transitory fever (inanition temperature, dehydration temperature) occurs on the third or fourth day, or at about the time when the minimum weight is reached. Infants with a high birth weight and, consequently, with a greater initial loss, are more apt to have transitory fever, but it occurs in smaller infants too. Usually there are no symptoms, but the fever may rise to 103 or 104 F. and even higher, and nothing is found on physical examination to account for it. The duration of the fever is short, seldom lasting more than two days, and often being recorded at only one temperature reading. The name "inanition temperature" should probably not be used to designate the condition, since it is not due to lack of food, but rather to lack of water. It can be prevented and cured by the administration of adequate quantities of indifferent fluids in the majority of cases, but water loss also plays an important rôle since the condition occurs, at times, where fluid intake has not been low. Other factors, such as the activity of bacteria in the intestinal tract, the thermolability peculiar to newborn infants, and idiosyncrasies of constitution must be taken into consideration.

Icterus neonatorum may assume pathologic proportions and is then called *icterus neonatorum gravis.* This condition is characterized by an early appearance of a jaundice, usually in the first day, which becomes rapidly more intense until the skin has a yellow-green color; the urine contains soluble bile pigments, and the stools are intensely colored. The liver and spleen are enlarged. Somnolence and disinclination to nurse are prominent symptoms, and the general condition grows rapidly worse. Death usually occurs before the end of the first week. The etiology of this form of icterus neonatorum is unknown, but it probably rests upon a basis of some constitutional peculiarity. It has more than once been observed in several infants of the same parents. A few cases of recovery have been reported. In a few of these cases where symptoms of cerebral irritation have been noted, an intense icteric discoloration of the gray nuclei has been found at autopsy, and the name "nuclear icterus" has been used to designate them. Severe icterus with

bleeding nipples. For a more detailed discussion the reader is referred to text-books on pediatrics.

Small hemorrhages in the suprarenal glands are a very common autopsy finding in babies dying in the first weeks of life. Sometimes these hemorrhages, which are usually in the medullary portion and bilateral, become quite large, and involve the capsule as well. They may rupture into the retroperitoneal tissues, or into the free peritoneal cavity. The most striking clinical symptom is rapidly progressing anemia. Death may occur quite suddenly when the hematoma ruptures.

Bleeding from the umbilical stump as a part of this disease may occur as the only hemorrhagic symptom, but more often it is associated with hemorrhages elsewhere in the body.

Hemorrhages into the skin are apt to be in areas that have been subjected to trauma as, for example, the scalp, face and buttocks, if the hemorrhage takes place in the first days. When the hemorrhagic condition does not occur until the end of the first week, or later, ecchymoses and even large effusions of blood may be found in the skin on any part of the body. In premature infants, very large areas of skin hemorrhage are often seen in the first days of life.

Hemorrhages in the mucous membranes are found chiefly in the mouth and nose. Those in the nose, particularly, are of practical significance because the bleeding may be profuse, and the swallowed blood, when vomited or passed in the stool, can cause suspicion of true melena, since the source of the hemorrhage is often difficult to determine. Nasal hemorrhage may also occur as an accompanying symptom of syphilitic rhinitis, nasal diphtheria, and sepsis.

Intracranial hemorrhage undoubtedly does occur as a result of hemorrhagic disease of the newborn, but to what extent the disturbance of the coagulability of the blood is a factor, is in most cases of intracranial hemorrhage, impossible of determination. There are so many factors involved, as has been mentioned under the heading "intracranial injuries," that the rôle of hemorrhagic disease can only be guessed at. Its chief significance is that when superimposed on an already existing hemorrhage, it can be the cause of a recurrence of hemorrhage, and thus increase the size of the hematoma. Symptoms may thus be produced after a latent period, or symptoms already present increased in severity.

The *treatment* of hemorrhagic disease of the newborn concerns chiefly the employment of measures to combat the faulty coagulation. When this factor is entirely or mainly responsible for the condition, the results have been excellent. The treatment of choice is the injection of blood. The simplest and therefore the preferred method of administering blood is intramuscular injection. Fifteen to 20 cc. of blood is drawn from an arm vein of a donor, usually the father or mother, and immediately injected into the gluteal muscles or muscles of the back. Usually one injection suffices, but it may have to be repeated after eight to twelve hours. Should there be no improvement following such treatment, 50 to 100 cc. of citrated blood should be injected intravenously, or intraperitoneally. Blood used for intraperitoneal or intravenous injection should be typed even if taken from a parent. Human serum or horse serum may be used if necessary. Good results have also been claimed for sterile gelatin, 20 cc. of a 10 per cent solution injected subcu-

type used by the author was built at his direction by the hospital carpenter, and is modeled after the incubator introduced by Professor E. Nobel of Vienna. It is essentially a wooden box without a floor, with an arched opening at one end. This box is placed upon the bed over the baby, so that the baby's head protrudes through the arched opening. The box is heated by means of an incandescent light bulb.

The problem of meeting the nutritional requirements is difficult; the digestive organs are immature, and feeding must be carefully supervised. Breast milk is all-important, but since the infant is usually too weak and immature to nurse directly, the breast must be emptied by artificial means,

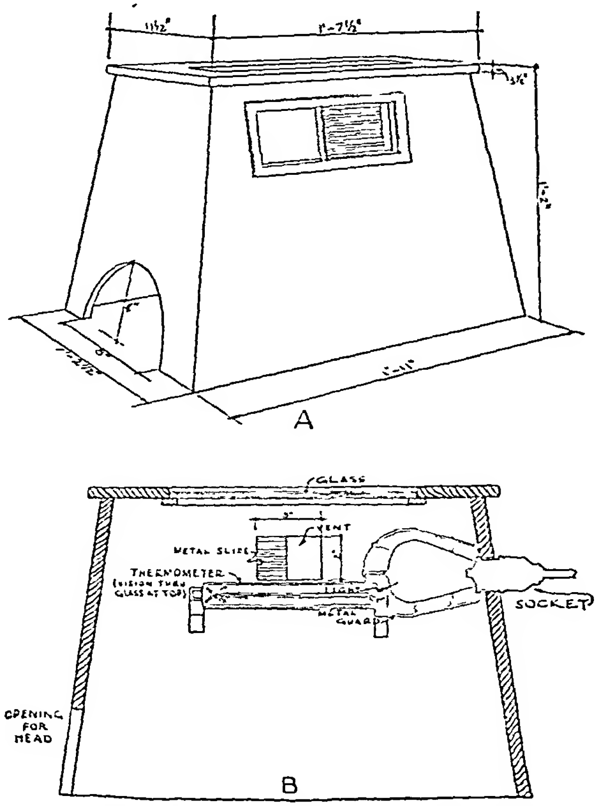

Fig. 462.—Illustrating construction and equipment of incubator for premature infants.

and this involves the risk of the mother's milk giving out completely, or of being insufficient. Finally, nearly all of the smaller premature infants have to be fed, for a time at least, by means of a tube or a dropper. In addition to these difficulties, there are the dangers to the child of attacks of asphyxia when feeding is attempted, and the further danger of aspiration of food with suffocation or aspiration pneumonia. The method of feeding used by the author is the following: Nothing is given during the first twenty-four hours; feeding is then started by giving 1 ounce of breast milk every four hours by tube, and $\frac{1}{4}$ ounce midway between feedings by dropper; after four or five days, the amount given by tube is increased to $1\frac{1}{4}$ ounces and the amount given by dropper to $\frac{1}{3}$ ounce; this is continued for another period of about

but phlebitis may occur. Umbilical granulomas are comparatively frequent and are the result of delayed healing and a heaping up of excessive granulation tissue. Unless these granulations are destroyed the small tumor may persist for weeks. Cauterization with silver nitrate is usually sufficient to clear up the condition.

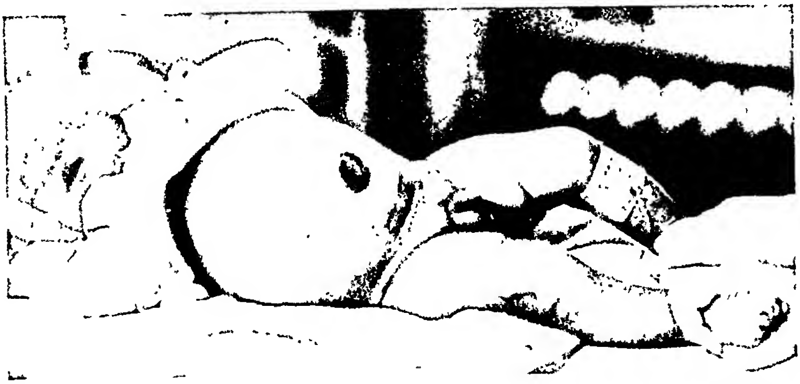

Fig. 464.—Same case as Fig. 463 showing appearance of the umbilicus amnioticus on the tenth day. There is also a rather large umbilical hernia.

Affections of the Skin.—Congenital skin defects are most frequently seen on the scalp in the form of round or oval slightly raised excoriations with a bleeding surface or they may be already healed and covered with scar tissue. The defect may extend into the deeper tissue, even involving the bone and giving rise to brain hernia. Other areas of the body surface may be the site of skin defects and they are sometimes quite extensive.

Fig. 465.—Hernia into the umbilical cord.

Telangiectatic nevi are seen most frequently at the nape, on the central portion of the forehead, the upper eyelids, the alae nasae, and the upper lip. They appear as faintly red discolorations of the skin and are not raised above the level of the skin surface. After twelve to twenty-four months they are no longer visible.

Mongolian spots or *blue birth-spots* are areas of bluish discoloration of the skin located over the sacral area as a rule, but in exceptional cases may cover a large part of the body surface; the ventral surface of the trunk, and the

sterile but there have been reports that streptococci have been cultured in a few cases. The explanation of these lesions is still not clear.

The treatment is carried out in a variety of ways but the underlying principles are much the same everywhere. Strict isolation is the first step. The local treatment is aimed at getting rid of the pustules and keeping the rest of the body surface clean and dry in order to lessen the possibility of new lesions developing. It is recommended by many that the individual lesions be opened and the purulent contents carefully sponged off, after which some disinfecting solution, ointment or dusting powder is applied. If the lesions have extended over a large portion of the body surface disinfecting baths may be of value. Detailed directions for the treatment of individual cases cannot be given here.

Ophthalmia Neonatorum.—Although many different bacterial organisms may cause ophthalmia in the newborn the term "ophthalmia neonatorum" is generally used to designate infection with the gonococcus. The organisms gain access to the conjunctival sac in the passage of the head through an infected birth canal. Signs of catarrhal inflammation are usually first seen on the third or fourth day; the lids are slightly inflamed and a moderate discharge of a serous or serosanguinous exudate occurs. After two or three days there is a copious thick purulent discharge and the lids are much swollen and inflamed. The subsequent course depends upon a virulence of the infection and the manner of treatment. Because of the serious consequences of damage to the eye proper treatment is urgent. The prophylactic measures now in common use in all civilized countries have been of great humanitarian service, and no laxity in carrying out these measures must be permitted. Many cases of ophthalmia are due to inefficient use of the Credé treatment.

Infection of the Salivary Glands.—The salivary glands may become infected either directly from a contaminated mouth cavity or by way of the blood stream in the course of a general sepsis. The condition is comparatively rare. The parotids are said to be more frequently infected than the submaxillaries but in the author's experience the reverse has been true. Swelling of the gland occurs, accompanied by fever and refusal of food; the gland becomes very tender and within twenty-four hours the overlying skin may be reddened, in which case the gland rapidly suppurates and has to be incised. In less fulminating cases pus may be expressed through the excretory duct by gentle pressure over the gland, and the process will subside spontaneously.

Tooth Bud Infections.—The tooth buds also may become infected by a direct route through the mucous membranes or by the hematogenous route. In the latter case there is usually an associated infection of the maxillary or mandibular bone. Several tooth buds are usually involved and are cast off through an opening in the alveolar mucous membrane, and an abundance of pus continues to be discharged through the sinus thus created. Swelling of the cheek or lips accompanied by fever should make one suspicious of this condition. The mortality is high.

General Sepsis and Pyemia.—These conditions are seen so infrequently during the newborn period that a complete discussion is out of place here. The common portals of entry are the skin surface, the oral cavity, the umbilicus, and the intestinal canal. Certain peculiarities of the newborn are responsible for some features of their clinical manifestations; *e. g.*, a tendency for hemorrhages to occur in the skin, in the intestinal canal, from the umbilical

CHAPTER XXVII

CHANGES IN THE FETAL CIRCULATION FOLLOWING BIRTH

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The results of several recent investigations have indicated that certain long-cherished traditions as to the circulation of the term fetus are no longer tenable. That this information has come fragmentarily from various independent workers and is still mutally confirmatory makes it especially cogent. In view of this new knowledge, and as a basis for interpreting the changes which occur following birth, it becomes doubly important for us to consider in some detail the circulation as it exists just prior to birth.

THE FETAL CIRCULATION

Controversies concerning the course of blood through the fetal heart have been smouldering, with periodic outbreaks, ever since the times of Harvey. The historical phases of the subject have beeen thoroughly covered by Pohlman[24] (1909) and more recently again by Kellogg[12] (1928) so they need not be gone into here. The striking thing is the persistence of the Sabatier[28] (1791) doctrine that the entire inferior caval stream carrying the freshly returned placental blood passes directly through the foramen ovale to the left atrium, while the superior caval current of blood, depleted by a systemic circuit, passes with little or no mingling into the right ventricle. Possibly there exists, because of greater familiarity with the adult circulation where separation of pulmonary from systemic blood is so strikingly maintained, an unconscious bias toward interpreting the fetal circulation in terms of blood currents which maintain their identity. Whatever the underlying reasons may be, current text-book illustrations bear eloquent testimony as to the tenacity of the Sabatier conception in the face of an increasing accumulation of evidence against it. It is true that early injection experiments (*e. g.*, Reid,[25] 1835) appeared to give some support to the Sabatier theory. But these experiments, made with heavy starch masses in dead material, when reviewed in the original appear too equivocal to justify the wide citation they have received.

Pohlman[24] (1909) carried out the first really critical experiments devised to ascertain the course of blood through the fetal mammalian heart. In living pig embryos he injected colored starch grains into the circulation and, by repeated counts of the grains appearing in blood recovered from the right and left heart, demonstrated that mixing of inferior and superior caval blood occurred in the right atrium. Clear-cut as were Pohlman's results, they had little apparent influence on the propagation of the Sabatier theory of crossed pure currents.

In 1928 Kellogg repeated and extended Pohlman's experiments. Working with cats and dogs as well as pigs, and varying both the sites of injection and of recovery, Kellogg amply confirmed Pohlman's conclusions. Moreover,

available any quantitative determinations of the blood flow through the fetal lungs, all the implications are against the current view that the pulmonary circulation is negligible. It is out of line with everything known about the development of the vascular system to think of vessels growing beyond a capacity consonant with their present activities. Nor is this argument by analogy the only angle of approach open. Injection or perfusion of the vascular tree of uninflated lungs seems to offer little if any more resistance than injection of inflated lungs. Moreover, measurements of the pulmonary vessels in individuals just before birth show them to be of virtually the same capacity as they appear in other individuals that died after breathing for two or three days.* The actual size of the fetal pulmonary veins as

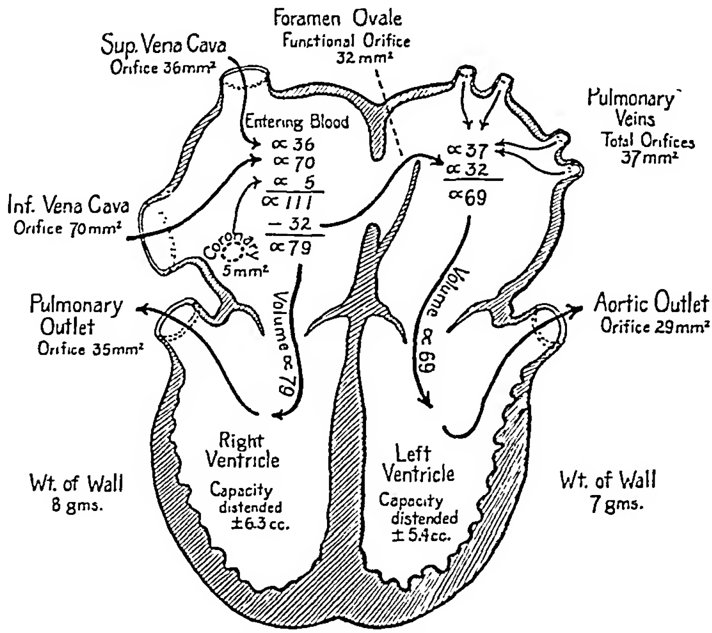

Fig. 470.—Schematic diagram showing dimensions of 20-Gm. heart from normal full-term fetus. For the sake of simplicity the measurements for this typical heart are given to the nearest integer. Tabulated measurements from a series of over fifty hearts ranging from 15 to 30 Gm. show the constancy of the significant relationships here indicated. (Patten, Amer. Heart Jour., 1930, vol. vi.)

determined by these measurements indicates that they bring into the left atrium a volume of blood somewhat greater than that contributed by way of the restricted functional orifice of the foramen ovale. The fact that the left side of the heart receives much less blood by way of the foramen ovale than hitherto believed, but receives a correspondingly greater amount from the pulmonary circuit, leaves undisturbed the conception of an approximate

* These figures for the pulmonary vessels and those that follow for other cardiac orifices are given from preliminary tabulations of work still in progress (Patten and Toulmin[23]). None of the average measurements here given are based on fewer than forty hearts. In some instances more than 100 cases have already been measured. The close agreement of sample group averages indicates that the results of the greater number of individual measurements it is planned to make before publication of the detailed data will differ but fractionally from those given here.

ovale brings, instead of practically all, less than half the blood entering the left atrium. On the basis of vessel size, the fetal pulmonary circuit brings in more than half the blood entering the left atrium. The blood shunted from right to left through the foramen ovale does not quite raise the blood volume estimated as entering the left atrium to equality with that entering the right. That this is a real difference and that the load carried by the right and left sides of the heart is not absolutely balanced is confirmed by the slightly greater size of the right ventricular lumen, the slightly greater weight of the right ventricular musculature and the somewhat greater size of the pulmonary than the aortic outlet (Fig. 470). These facts all accord with the characteristic right ventricular preponderance exhibited by electrocardiograms of the neonatal heart.

It is unwise to draw too specific conclusions about the circulation from such measurements alone. At present, however, there are available practically no pressure or volume determinations on the fetal circulation. In the sizes of the channels we have at least the start of a quantitative basis of interpretation hitherto lacking. That these measurements are not without functional significance is indicated by some simple comparisons. In the fetus, aortic and pulmonary pressures may be assumed to be equal because of the free communication of these vessels through the ductus arteriosus. This assumption is in accord with the only experimental evidence we have on blood pressures in the fetal heart, Pohlman's observations that blood rises to equal heights in capillary tubes inserted in the right and in the left ventricles. If the pressures are equal, the relative sizes of the arterial outlets and the relative weights of the ventricular walls should both be indicative of the amount of blood handled by the right and left sides of the heart. In that case we should expect the two ratios to equal each other. That is:

$$\frac{\text{Right Ventricular Weight}}{\text{Left Ventricular Weight}} \text{ should equal } \frac{\text{Area Pulmonary Outlet}}{\text{Area Aortic Outlet}}$$

Writing into this proportion the average of actual measurements made on fetal hearts:

$$\frac{8}{7} \text{ should equal } \frac{35}{29}$$

The correlation figures at 0.94 where 1 is the expectation.

Since the atria of the fetal heart are in open communication, some of the greater intake of the right atrium will tend to be passed on by way of the foramen ovale to the left atrium.

ENTERING RIGHT ATRIUM		ENTERING LEFT ATRIUM
Orifice of superior vena cava,	36 sq. mm.	
Orifice of inferior vena cava,	70 "	Total cross-sectional area of pulmonary veins 37 sq. mm.
Orifice of coronary sinus,	5 "	
Total,	111 "	

$$-32 \longrightarrow \text{Functional Orifice of Foramen Ovale} \longrightarrow 32 \text{ sq. mm.}$$

Blood volume $\propto$ 79 sq. mm. inlets $\propto$ 69 sq. mm. inlets

↓ ENTERING RIGHT VENTRICLE   ↓ ENTERING LEFT VENTRICLE

blood flowing from the inferior vena cava into the right atrium and thence through the foramen ovale to the left atrium. With the first breath, the preformed, but hitherto practically unused, pulmonary vessels suddenly opened and allowed a rush of blood to pass into the lungs. By the very power of its surge into the left atrium the blood returning from the lungs forced the valvula foraminis ovalis to close against the weakened caval current impinging on its right atrial face. Inflation of the lungs shifted visceral relations, putting the ductus arteriosus on so much of a stretch that blood could no longer pass freely through it and, presto! the newborn infant had an adult type of circulation. It is a dramatic story lending itself well to diagrammatic exposition within brief compass, but it will not stand scrutiny.

In its older form, the idea of the immediate closure of the foramen ovale was crudely mechanical. There was supposed to be an active shutting off of this passage which forced a rerouting of the blood through the heart. If such closure failed to occur, cyanosis and death were supposed to result. One will find this view still expressed in many current text-books of embryology and obstetrics. And case after case can be found in present-day hospital and public health records implying the same viewpoint by accusing an open foramen ovale of being the cause of death in a neonatal individual where an unclosed foramen ovale is absolutely normal. Belated recognition of the long-known fact that closure of the foramen ovale is not completed until several months after birth is slowly forcing a retreat from such traditions.

A more recent view holds that although anatomical closure of the foramen ovale is delayed, its functional closure is immediate. Even this modified conception of an immediate closure which is functional rather than anatomical is a corollary of the old Sabatier hypothesis. The first critical event leading toward closure is supposed to be a reduced inferior caval current due to interruption of the placental circuit. If, as recent work clearly indicates, there exists no pure current of inferior caval blood traversing the right atrium and making its way directly through the foramen ovale, this contention loses all weight. If there is free mingling of the blood currents entering the right atrium, flow through the foramen ovale must be determined by the difference between the rates of intake and the resultant pressures which exist on either side of the interatrial septum. Unfortunately we have no experimental data on these critical matters. But what effective reduction can interruption of the placental circuit bring about in the relative volume or pressure of blood entering the right atrium as compared with that entering the left? No maternal blood was coming to the fetus from the placenta. After the tying of the cord, as before, all the blood in the systemic circuit must return to the right atrium. Possibly after the placenta is cut off, relatively more blood enters through the superior cava. But change in the relative amount of blood returned by the two cavae will not alter the pressure relation between right and left atria. As far as the heart is concerned the immediate result of tying off the umbilical vessels is merely to eliminate from the fetal circulation the blood that happened to be passing through the placenta at the moment. It can have no more effect on relative pressures in the two atria than loss of the same amount of blood by superficial hemorrhage. One might as well try to effect the closure of the valvula foraminis

high hemoglobin index of the fetus and neonatal infant afford an increased oxygen-carrying capacity in the same manner that these conditions are known to operate in adults with certain types of congenital defects of the heart. Finally, the infant does not indulge in physical activities of a type which put a sustained excessive demand on oxygen intake until ample time has elapsed for readjustment to postnatal conditions.

There is, in brief, no functional exigency that forces us to postulate a violent postnatal increase in the volume of the pulmonary circulation. That there is some immediate acceleration of flow under the influence of the massaging effect of respiratory movements seems highly probable. But the radical increase in the volume of circulation necessary even to approximate an equalization of left with right atrial intake must await the gradual enlargement of the pulmonary channels in response to functional activity. Just how long a time elapses before such equalization takes place we can know with exactness only when there are available critical pressure determinations for both fetal and neonatal circulation. There are, however, many facts which, when arrayed, fit together in a suggestive manner.

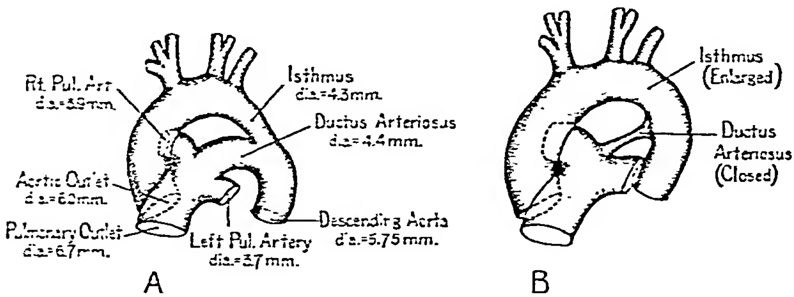

Fig. 472.—Diagrams showing the characteristic postnatal change in the isthmic region of the aortic arch. A, Fetal condition at full term. The vessel diameters are averages from the measurements of 30 cases. B, Typical configuration three to four months after birth. Note the enlargement of the isthmic portion of the aortic arch which accompanies the reduction of the ductus arteriosus. (From Patten, Amer. Heart Jour., 1930, vol. vi.)

First there are three well-known phenomena which appear not to have been emphasized hitherto in connection with the circulatory changes following birth. (1) The lungs of neonatal infants coming to autopsy characteristically show incomplete inflation. In other words, the lungs come into full functional activity but gradually. The atelectatic areas become progressively smaller until complete inflation is reached, normally about the third or fourth postnatal week. (2) The high red cell count and the high hemoglobin index characteristic of the fetus and neonatal infant rapidly decrease during the first month after birth (Japha,[11] 1908). This decrease probably parallels the increase in volume and efficiency of the pulmonary circulation. (3) The portion of the aorta between the origin of the left subclavian artery and the entrance of the ductus arteriosus (isthmic portion), which, in the fetus, is characteristically narrowed (Fig. 472), takes two months or more to widen to the bore of the aorta below the ductus. This seems indicative of a gradual cessation of ductus contribution to aortic current, and of a gradual gain in the power of the blood stream delivered by the left side of the heart to the aortic arch proximal to the narrowing. This in turn

made with a calibrated cone show that a progressive diminution in the size of the functional orifice between the valvula and the septum is taking place during this period. By two months the interatrial communication has ordinarily been reduced to functional insignificance (Table 2).

TABLE 2

MEASUREMENTS OF THE FUNCTIONAL ORIFICE OF THE FORAMEN OVALE AT VARIOUS AGES*

Heart number.	Age.	Heart weight in grams.	Functional orifice foramen ovale in sq. mm.
Average of 40 cases	At birth	22.4	30.1
75	7 days	18.7	22.9
251	19 days	19.0	7.1*
239	20 days	27.5	13.8
114	21 days	16.1	11.3
232	27 days	24.0	10.2
246	5 weeks	23.1	8.0
261	7 weeks	28.1	9.1
			Probe patency in sq. mm.
249	2 months 4 days	27.5	4.5
230	2 months 10 days	23.1	4.5
240	2 months 27 days	25.0	2.0
115	4 months	22.3	2.1
253	5 months	21.1	8.1*
58	5 months	23.0	3.8
120	5 months	24.9	5.3
252	5 months	25.0	2.0
228	6 months 1 day	38.1	9.1*
255	6 months 7 days	37.2	1.5
56	7 months	39.8	2.0
11	7½ months	34.0	7.1*
254	8 months	40.0	0
243	8 months 19 days	51.8	2.0
121	9 months 14 days	35.0	0

* While conditions at birth can be established by averaging a number of measurements, because of the impossibility of securing any number of hearts of exactly the same age and weight, only typical individual measurements can be given after birth. After the second month the term "degree of probe patency" is substituted for "functional orifice" because the valvula has by this time become so thickened and so tightly stretched against the septum that probably little or no blood would pass by it, although a calibrated tapering probe will dilate the opening to the area indicated. Among the typical cases have been included cases (starred) illustrating the variability which is encountered. For the general trend of events read the table without these exceptional cases.

Other changes leading toward the ultimate obliteration of the foramen ovale follow more slowly. In the newborn infant the valvula foraminis ovalis is composed practically entirely of muscle with but a thin endocardial covering (Fig. 475). Toward the end of the second or beginning of the third postnatal month there commences a striking increase in its fibrous tissue. In the ensuing six months *the connective tissue component of the valvula* increases from 600 to 700 per cent, while there is in the same period no appreciable increase in the muscle tissue (Fig. 476). Throughout this period a fine probe can still, in most cases, be slipped beneath the valvula, although the slit through which the probe may be passed diminishes progressively and the resistance to its passage increases with the increase in thickness of the

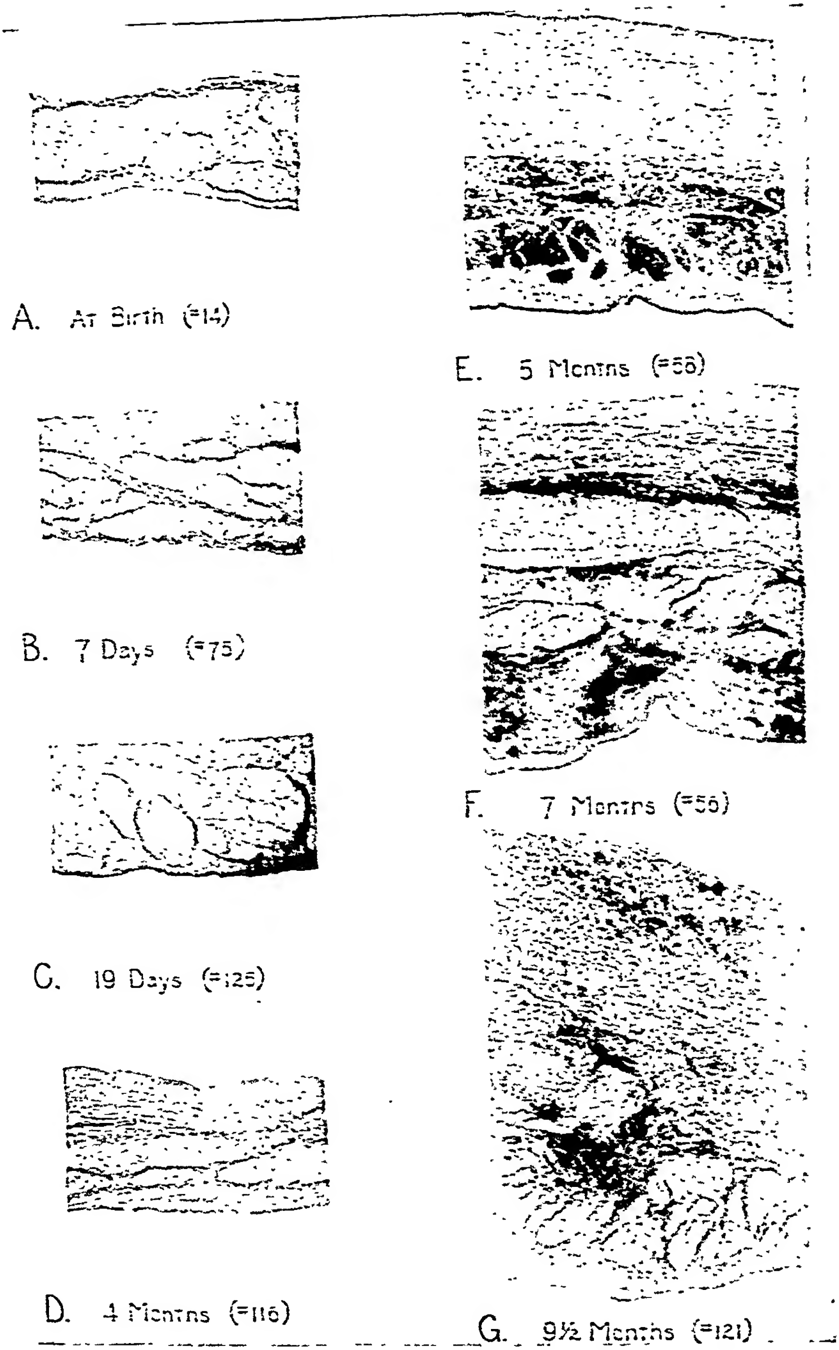

Fig. 476.—Photomicrographs showing the tremendous increase in connective tissue which occurs in the valvula following birth. Note that there is no appreciable increase in the muscle tissue during this period. All figures are of same magnification (× 50) and taken from the portion of the valvula indicated in Fig. 475. (Patten, Amer. Jour. Anat., vol. 48.)

first year after birth, and is frequently much later (Tables 3 and 4 and Fig. 477).

Mere failure of absolute completion of the fibrous union of the valvula with the septum should be sharply distinguished from the freely movable and slack valve as it occurs in cases of pulmonary stenosis, and from the frankly abnormal conditions in which the foramen ovale remains inadequately guarded because of definite structural defects (Fig. 478). Incomplete adhesion with probe patency is so common that it must be regarded as a variant of

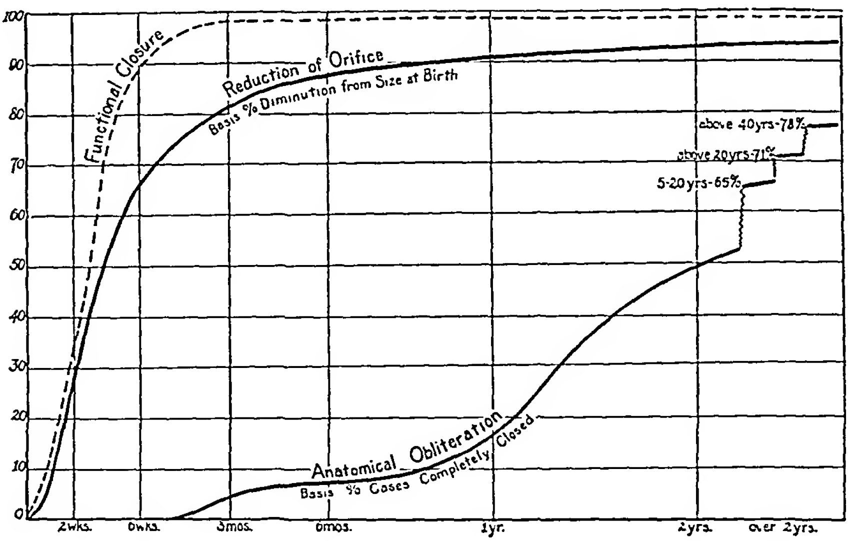

Fig. 477.—Smoothed curves summarizing the progress of events in the closure of the foramen ovale. The dotted curve showing the rate of functional closure is based on circumstantial evidence and should be regarded as tentative (see text). It expresses the progressive abandonment of the foramen ovale, which parallels diminution in bore of the ductus arteriosus and increase in pulmonary return to the left atrium. The failure of this curve to reach 100 per cent is meant to indicate that in any large group of hearts a few (± 1 per cent) will be found in which functional occlusion of the foramen ovale is impossible because of congenital defects in the structure of its valvular mechanism (Fig. 478). The curve labeled "reduction of orifice" is based on actual measurements of the effective interatrial communication at various ages after birth (Table 2). The average size of the functional orifice at birth is taken as a basis for expressing the percentage of reduction in size that this orifice has undergone at various ages. This curve does not rise as near 100 per cent as the curve of functional closure, because small probe patencies of no functional significance persist in so many individuals (Table 5 and Fig. 479). The curve labeled "anatomical obliteration" records the percentage of individuals at various ages which may be expected to exhibit absolutely complete fibrous union of the valvula with the septum (Tables 3 and 4). (Patten, Amer. Jour. Anat., vol. 48.)

the normal rather than as an abnormality. Approximately 25 per cent of all adult hearts show it in some degree (Table 5). As long as the valvula foraminis ovalis lies tightly against the septum and adequately overlaps the limbus fossae ovalis (Fig. 479), probe patency is no functional handicap to an otherwise normal individual.

This whole matter of the adhesion of the valvula to the septum—when it occurs, whether or not it is absolutely complete and so on—has provoked so much futile controversy that the really important matter of functional

TABLE 5

RECORDS AS TO COMPLETENESS OF CLOSURE OF FORAMEN OVALE, PRIMARILY FROM ADULTS, BUT DATA NOT SEPARATED ACCORDING TO AGES

Observer.	Number of cases examined.	Not completely closed.
Adami-Abbott, 1915[1]	1374 (adults)	199
Bizot, 1837[4]	155 (mostly adults)	44
Brit. Anat. Soc., 1898 (Parsons and Keith[19])	316 (all above 10 years)	76
Fawcett and Blachford, 1900[7]	306 (all over 6 years)	96
Hinze, 1893[10]	359 (all over 20 years)	82
Klob, 1858[11] (from Vierordt[34])	500 (ages not stated)	224
Ogle, 1857[17]	62 (adults)	13
Rostan, 1884,[27] and Zahn, 1889[36]	711 (661 over 20 years)	139
Wallmann, 1859[35]	300 (291 over 20 years)	130
Totals	4083	1003

Foramen ovale not completely closed in 24.6 per cent of cases.

With the new functional balance in the circulation established on a working basis, the final steps are taken in leisurely fashion and without the synchronizing that is so marked a feature of the initial changes. During the second or early in the third month, what remains of the lumen of the ductus arteriosus is obliterated. If any single event can be regarded as

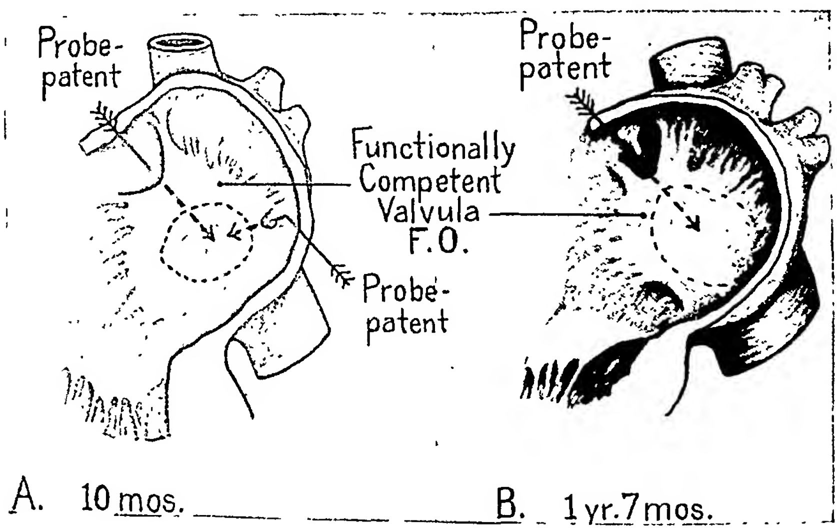

Fig. 479.—Examples of hearts showing the foramen ovale guarded by a valvula ample in its overlap, but incompletely fused to the septum. Such cases show what may be designated as adequate functional closure with a persistent probe patency. Probe patencies of this type are apparently no functional handicap to an otherwise normal individual and persist in about 25 per cent of all adults (Table 5). (Patten, Amer. Jour. Anat., vol. 48.)

signalizing the end of the phase of primary readjustment it is the completion of the closure of the ductus, at an average age of about eight weeks. As we have seen, the final anatomical obliteration of the foramen ovale is delayed and variable. The dynamic factors responsible for the enlargement of the isthmic portion of the aortic arch do not come into full play until the ductus

between right and left atrial intakes is established which throws the compensating one-way valve at the foramen ovale into disuse. Although a probe can still be passed between the valvula and the septum, the foramen ovale may be regarded as functionally closed when this new intracardiac balance has been established.

Increase in the thickness of the valvula and finally its fusion to the septum follow leisurely in the wake of the functional closure of the foramen ovale. Both the time at which adhesion occurs and the completeness with which all traces of the original lumen are obliterated are highly variable and of little functional significance in an otherwise normal individual.

Finally, responding to the added load imposed on it by the new postnatal balance in the circulation, the left ventricular musculature begins to increase more rapidly than does the right. Somewhat less than the right at the time of birth, the left equals it in weight by three or four months, and thereafter continues slowly to gain until its full preponderance is reached somewhere around the seventh year.

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CHAPTER XXVIII

MULTIPLE PREGNANCY

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It is normal to bear one child at a time, and this is the general rule for all other animals in which the gestation period exceeds six months. In most animals the number of teats characteristic of the species, according to Marshall, affords an approximate indication of the average size of the litter. Furthermore, the average number of young produced in a litter in any species of mammal is, with few exceptions, inversely proportional to the average size of the animals belonging to the species.

Multiple pregnancy implies the coexistence of more than one fetus in the uterus. In the strictest sense, the presence of one ovum in the tube and another in the uterus and twin tubal pregnancy are also instances of multiple pregnancy. The latter conditions are separately treated in the chapter on Ectopic Pregnancy. The frequency of multiple pregnancies (about 1.17 per cent) varies with the fertility of the people, and this also varies in different countries, at different periods. Thus, DeLee states that multiparae, especially those having frequent pregnancies, are more likely to bear twins, and that the probability of twinning increases after thirty-three years of age. On the other hand, Das of Calcutta, from a study of 377 cases of twins, maintains that women are more prone to have twins in their first pregnancy and that the percentage diminishes with successive pregnancies. Possibly the custom of early marriage in India helps to account for this discrepancy.

The number of fetuses in the uterus in multiple pregnancy may vary from two to six, about 5 authentic cases of sextuplet births being on record. The frequency of twins is usually given at 1 in 87 births, varying from 1 in 73.6 (Rotunda) to 1 in 101 (Bertillion). D. Hellin's formula of incidence (quoted by Bumm): twins 1 in 80 births, triplets 1 in 80^2, quadruplets 1 in 80^3, quintuplets 1 in 80^4, agrees fairly closely with the analysis of Guzzoni's statistics of over fifty million births. Another way of expressing the simple relationship of human twin and triplet births is twins $1/n$; triplets $1/n^2$, quadruplets $1/n^3$, etc. Zeleny offers a plausible explanation for the occurrence of multiple pregnancy according to this rule.

Triplets are encountered once in 6,209 births (Dubois) to 1 in 7,103 (Guzzoni). Quadruplets occur 1 in 371,126 or 1 in 71.9^3 (Veit), to 1 in 757,000.

About 30 cases of quintuplets are on record, and sextuplets, according to Williams, have authentically been recorded in but 5 cases.

The tendency to multiple pregnancy is looked upon as an atavistic reversion transmitted especially through the mother, but may be carried by either parent. When both sides bear the hereditary impulse, the tendency is accentuated, and repeated multiple pregnancies may result. Multiple

of gastrulation, the critical moment for twinning, is responsible for the production of twins. This applies equally to conjoined twins, the type of deformity depending upon the precise moment of interruption (Arey). Monochorial quadruplets have been recorded authentically twice (Hermstein and Pfalz).

Binovular twins are the more frequent (80–85 per cent) and are derived from separate ova. They may be of the same or different sex just as in two successive births. The ova may come from one or from both ovaries. The fact that a single corpus luteum is frequently found in women dying after twin births has been cited as evidence of multiple ova in a single graafian follicle. However, a second inconspicuous corpus luteum might be present in the other ovary in such cases. Strassmann described a section

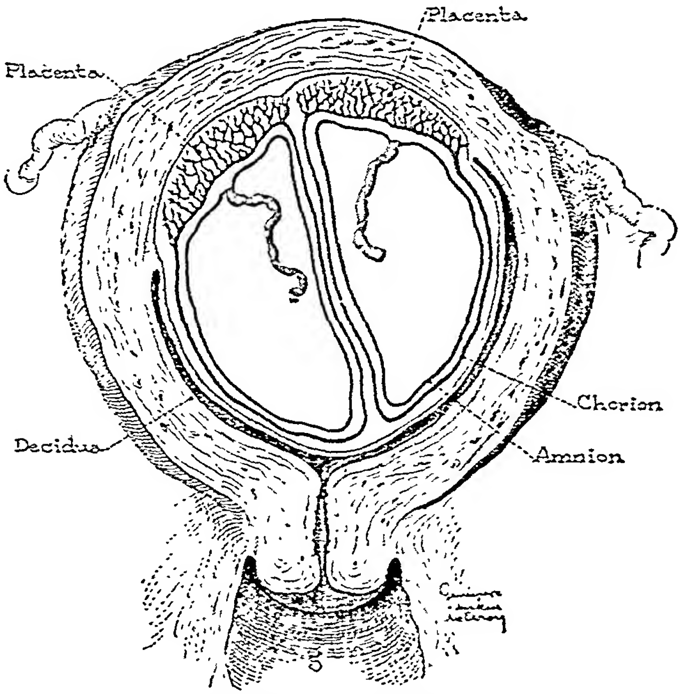

Fig. 481.—Double ovum or fraternal twins.

of an ovary in which almost every follicle contained two ova, and Bumm observed some follicles with two and even three ova in the ovary of a mother of twins. Hartman states that although rare in most individuals of a species, polynuclear ova or polyovular follicles may be present in great numbers in occasional individuals. In the opossum's ovaries polynuclear ova are the rule, and in some ovaries they occur by the hundreds. In Stöckel's human case all of the many binuclear and trinuclear ova were in primordial graafian follicles. The theory of single ovum (binuclear) twinning in the human is held untenable because no binuclear egg has yet been seen in a normal *ripe* graafian follicle. Bishoff even goes so far as to state that it is impossible for binuclear human eggs to exist. Twins that might arise from binuclear ova are essentially dizygotic, hence would not explain the identity in (monovular) twins. Hartman explains, in this connection, that polynuclear ova

sac which was formed by fusion or inclusion of the chorions. Amniotic fusion has definitely been observed in 12 cases of twins.

Homologous or identical twins have but one placenta in which the two fetal circulations anastomose freely. Usually there are separate amniotic sacs, but occasionally (about 40 cases on record) they occupy a common sac due to the disappearance of the septum. Two cords usually develop; rarely there is a single cord which bifurcates near the fetuses. The children closely resemble each other both physically and mentally, are always the same sex, and may even possess the same deformities. Swanberg and Haynes reported a case of mongolism in one of (binovular) twins.

Twins are usually smaller than single births but the combined weight of the two is greater. There are numerous cases on record of repeated multiple pregnancies often revealing the tendency to accentuate the hereditary impulse if carried by both parents. Thus Bumm quotes Valenta who reported on the remarkable fertility of a poor Viennese woman who bore twins three times, triplets six times, and quadruplets twice, a total of thirty-two children. The husband was a twin and the wife one of quadruplets. The hereditary tendency toward triplet pregnancy was found by Mirabeau in 13 of 75 cases, and in one family was manifested through five generations.

The occasional birth of twins of different size strongly suggesting a definite age discrepancy, or of twins which appear to be of separate races, has given rise to considerable speculation on the possibility of such phenomena. Cases have been recorded of twins being born weeks or even months apart, where the question naturally arises as to whether one was born prematurely and the other carried to full term, or whether the ova were fertilized at different intervals. These theoretical possibilities in the development of twins come under the heading of superfecundation and superfetation.

Superfecundation is the fertilization of two ova maturing at the same period of ovulation, by spermatozoids from separate acts of coitus. To prove the possibility of this phenomenon Schultze requires that the woman after coitus with two men of different races and other than her own, bear twins showing characteristics of both sires. According to Jellett and Madill, however, coitus of a white woman with a white and a black mate at about the same time, and the subsequent delivery of twins, one pure blooded and one mulatto, is sufficient proof of superfecundation. Such a case was reported by Archer in 1810. Williams cites a case which is difficult to explain except on a basis of superfecundation: a colored woman in her sixth pregnancy delivered twins one of which was healthy and one macerated. Syphilis was shown to be the cause of death of the latter both by microscopical examination of the placenta and upon autopsy of the fetus. The other child showed no evidence of the disease. The woman admitted coitus with her husband and with another man within a period of a few days, the latter being treated for syphilis at the time.

Superfetation is the fertilization of two ova maturing at separate ovulations and the nidation of the second ovum in the uterine cavity already occupied by the first growing ovum. The existence of superfetation in a normal uterus is very doubtful, and while it is possible that each half of a double uterus may carry a fertilized ovum of different age, it requires that ovulation continue after fertilization of the first ovum. As a rule, ovulation is suspended during pregnancy.

A marked difference in size of twins (uniovular) may occur due to the fact that the circulations communicate freely in the placenta. Thus the heart of the stronger fetus gets a larger share of blood at the expense of the weaker fetus. This may be carried to an extreme from early pregnancy so that the smaller is rendered a mere parasitic malformation—acardiac fetus. On the other hand, if one fetus dies early in pregnancy the other may continue to grow. The dead fetus, if not separately expelled, may come to lie between the amniotic sac of the living twin and the uterine wall and may be retained there as a fetus compressus or papyraceous. Entanglement of the two cords may lead to the intra-uterine death of one or both fetuses, which may likewise result from knotting of the cords. Postpartum hemorrhage is more likely after multiple pregnancy due to the weakened muscle fibers and the larger placental site which often extends onto the lower uterine segment. Interlocking or collision may occur, and if twins are markedly premature, the two fetal heads may enter the pelvis at the same time and become impacted. Locking may also occur in case the head of a second twin enters the pelvis before that of the first which presents by breech. When both present by

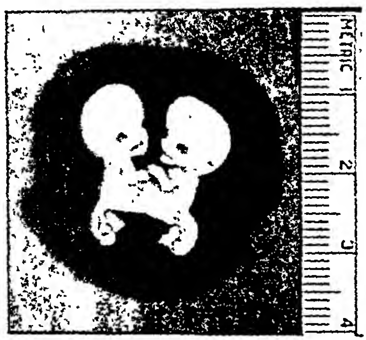

Fig. 490.—Xiphopagus. Spontaneous abortion at two months. (Michael Reese Hospital, Chicago.)

the head, one may be slightly in advance of the other, impaction resulting from the second head crowding the neck of the first child. When the first child is transverse, the second may sit astride the first; or the chin of a first twin presenting as a breech may engage in the neck of the second, transverse fetus.

Prognosis.—In multiple pregnancy the prognosis for the mother is poorer than in single birth due to the greater incidence of toxemias, greater cardiac strain, more chance of sepsis from prolonged labor and the vaginal manipulation usually required for the delivery of the second twin. Postpartum hemorrhage is also more frequent. The babies suffer from prematurity, intra-uterine circulatory disturbances, and possible separation of the first placenta before birth of the second twin. Joined twins, fetus papyraceous, and other monstrosities are not infrequent. The fetal mortality in twins, exclusive of nonviable and macerated fetuses, is 7.3 per cent as compared with 2.7 per cent in single births (Rotunda). The mortality of triplets and quadruplets is much higher.

Treatment.—Ordinarily there is no difficulty in the delivery of twins due to the small size of the fetuses which are often premature, and the

When an attempt has been made to extract the first child with forceps and impaction occurs, it may be found upon examination that the head of the second child has entered the pelvis with the chest of the first. If this impaction cannot be obviated by dislodging the second head, the first child must be sacrificed in order to obtain at least one living baby.

If the first child presents by breech and the second cephalic, the head of the second may precede the after-coming head of the first child, giving rise to locking. In this complication the locking may be chin to chin, or chin to

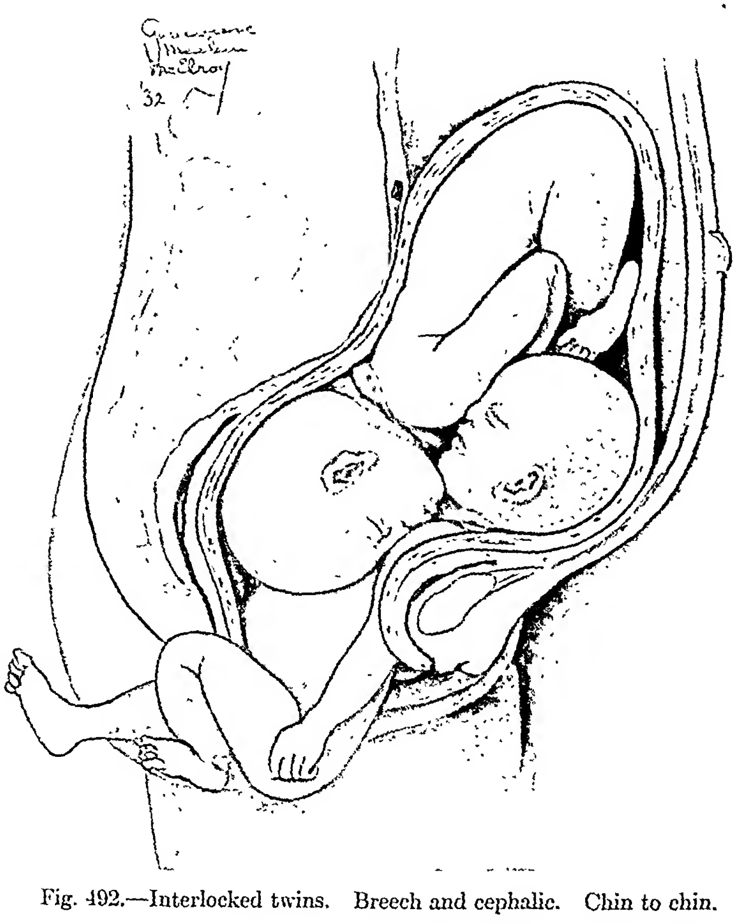

Fig. 492.—Interlocked twins. Breech and cephalic. Chin to chin.

occiput. To correct the difficulty an attempt should be made to dislodge the second head and push it up out of the pelvis. If it is found impossible to do this, decapitation of the first child which is partly born, and extraction of the second twin, after pushing up the severed head, is indicated.

The same principle is employed in treatment when locking occurs in a longitudinal-transverse combination. The second twin is extracted after podalic version, following disposal of the first child.

Cesarean section may occasionally be employed and may be the means of saving both twins when otherwise one or both would be lost. This course

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INTRODUCTION

THEORETICALLY, childbearing is a physiologic process; yet without exception pregnancy throws added burdens upon the maternal metabolic, circulatory and excretory functions. In general, the pregnant woman is subject to the same constitutional and infectious disorders as the nonpregnant. Indeed, many of the complicating diseases of pregnancy have antedated conception. For example, a myocardial weakness or a renal injury may remain latent for years until the strain of pregnancy gives it clinical expression in symptoms or signs of circulatory or renal incompetency. The hematopoietic margin of safety may be just adequate for ordinary needs; but the demands of pregnancy may plunge the woman into a state of serious anemia. Thus, illustrative cases might be multiplied to establish the contributory part played by pregnancy in disorders for which it is not primarily responsible. On the other hand certain complications may be directly traced to pregnancy. A minority of thyrotoxic patients fall into such a category.

attempt of a fetal compensation for a maternal deficiency is evidenced by Halsted's experimental removal of a portion of the thyroid gland from a pregnant bitch, whose puppies on birth all showed great enlargement of the thyroid gland.

Colloid Goiter and Hypothyroidism.—The work hypertrophy of the thyroid gland (Marine), or the simple colloid goiter, would seem to have no influence upon the course of pregnancy unless attended by hypothyroidism. In fact, this colloid change with enlargement of the gland can be completely controlled as a rule by the exhibition of iodine. The simplest form for its administration is an iodized salt. If more accurate dosage seems advisable, thyroxin may be utilized in doses of 0.5 to 1 mg. daily. This minute quantity represents the actual need of the body.

Hypothyroidism in the mother presents an entirely different problem. Whether arising upon a preexistent colloid goiter or independently, there is imminent danger of miscarriage. No less serious is the possibility of congenital goiter or cretinism in the offspring of such mothers. Litzenberg and Carey[8] reported the successful treatment of these cases after repeated earlier failures by the use of adequate thyroid extract.

Thyrotoxicosis.—Experimentally Kunde, Carlson and Proud[9] proved that rabbits with severe hyperthyroidism have oestrus, ovulation, fertilization, migration and implantation; but in most instances the young are never born. Resorption of the fetuses occurs in the latter two thirds of pregnancy. No direct parallelism exists in the human being. However Mussey, Plummer and Boothby[10] concluded that hyperthyroidism reduces the fertility to about 25 per cent of normal. Earlier studies by White[11] indicated the same tendency with the common experience of premature labor and antepartum hemorrhage, should pregnancy occur in such patients.

A few observers[12] question whether pregnancy seriously increases the toxicity of hyperthyroidism. In a great majority there is a marked accession in the symptoms of thyrotoxicosis with the onset of pregnancy when the thyroid disturbance antedates conception; and, too, pregnancy may initiate the manifestations of thyroid overactivity. In occasional instances the toxicity may retrogress late in the course of pregnancy with a relighting during labor and complete subsidence in the puerperium. The largest series of cases available for study have been reported from the Mayo Clinic.[10, 13] In the latter report[13] a total of 29 cases of Graves' disease and 12 of toxic adenoma of the thyroid gland is analyzed. The introduction of iodine in the medical treatment preparatory to surgery has so modified the outcome of these cases as to render earlier studies on this point useless. Twenty-two of the 29 cases of Graves' disease were met by partial thyroidectomy during pregnancy. Compound solution of iodine (Lugol's) was administered to all but 2 of this group. The remaining 7 were carried through their terms of pregnancy on medical management which included Lugol's solution. Three of these 7 patients had recurrent Graves' disease; 3 more were of a mild order, completely held in check by iodine after delivery; and thyroidectomy became necessary in the final patient a month postpartum. As to the 12 patients with toxic adenoma of the thyroid gland, 9 were submitted to thyroidectomy; 2 refused operation and 1 with mild manifestations was carried to term on medical treatment without iodine. Thirty-eight of the 41 cases reported in follow-up letters. The outcome of pregnancy was

pregnancy in the goiter belt. Not only may the maternal morbidity from thyroid disturbances be reduced, but also the incidence of congenital goiter may be greatly lessened.[19, 20]

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Parathyroid Glands

By experimental studies MacCallum and Voegtlin[1] fixed the responsibility for calcium metabolism upon these small glands. In pregnancy the maternal mechanism for maintaining the calcium balance is further taxed by the fetal demands for new bone formation. Contrary to the generally accepted opinion Ziskin[2] held that pregnancy per se is not a cause of dental caries nor has the frequency of pregnancy any bearing on the condition of the teeth. Blood calcium determinations would seem to indicate normal values throughout the period of gestation with some transient depression of the curve during lactation.[3] Few women show a definite lowering of the blood calcium during pregnancy.[4] Bokelmann and Bock[5] reported that the absolute content as

light in overcast weather and in winter, should be strongly urged. Calcium lactate or gluconate by mouth usually suffices to meet the needs of this group of subjects. If not, intravenous calcium chloride is indicated in doses of 10 cc. of a 5 per cent solution. Parathormone[14] may be utilized to speed the process; but as soon as the blood calcium exceeds 10 mg. per 100 cc. of blood and the electrical reaction passes the normal line, the dietary sources of calcium will suffice and cod liver oil may supplant viosterol. In the more acute manifestations of tetany, parathormone is almost indispensable, although inhalations of carbon dioxide may control the minor seizures by reducing the alkali reserve. Therapeutic abortion is not indicated.

Osteomalacia.—In all probability this is not a disease of the parathyroid gland; but since it has to do with calcium metabolism, it is considered at this juncture for convenience. Surveys, such as that of Scott,[15] indicate that osteomalacia complicating pregnancy is not uncommon in Asia. It may occur sporadically in certain districts of southern Europe, and apparently a majority of the cases observed in this country have immigrated from these areas. Calcium privation seems to constitute the essential background. The conspicuous clinical details of the condition relate to an inordinate loss of calcium and phosphates from the bones, which are thus rendered soft and even flexible in advanced cases. Particular obstetrical importance attaches to the earlier and predominant involvement of the pelvis, vertebrae and ribs, and their resultant deformities. This is especially noteworthy, because it is generally recognized that women with osteomalacia remain fertile and present a most serious problem in obstructed labor.

Medical judgment has for many years indicted the endocrine glands, as the responsible factor in osteomalacia, if the trend of therapy be a criterion. Beginning with Fochier,[16] Fehling,[17] Ogata[18] and others have advanced the theory of an ovarian responsibility and have advocated oophorectomy for its treatment. Their reported results are good; but McCrudden[19] found no favorable shift in the calcium metabolism upon experimental castration. Bossi[20] was responsible for the suggestion of the therapeutic value of adrenalin in osteomalacia; and Hoennicke[21] maintained a thyroid background. McCrudden and Fales[22] sharply arraigned these observers for their inadequate clinical studies and their uncritical viewpoints; they pointed out the importance of an initiating factor in an increased demand for calcium salts. In the male a bone tumor may act in this direction.

McCrudden[23] subscribed to the Cohnheim theory of uninterrupted apposition and resorption of the elements of bone, in contrast to Virchow's belief in a permanency of the inorganic elements of bone. McCrudden found, by experimentation, that in childhood apposition of lime salts is normally more rapid than destruction. In later life a preponderance of destruction over apposition of lime salts would lead to osteomalacia. Under such conditions he found new bone laid down which was poor in calcium phosphate and rich in organic matter and magnesium phosphate.[24] Scott[25] found the blood calcium, as well as that excreted in the urine, increased in osteomalacia. The latter figures were not significant in a differential or diagnostic sense.

The relationship of osteomalacia to pregnancy and lactation has been recognized for many years. McCrudden[23] remarked its occurrence usually only after repeated pregnancies. Its first appearance is usually in the late

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Pancreas

The pancreas arrests the attention particularly by reason of the common disturbance of the sugar metabolism in pregnancy. Williams[1] reported sugar in the urine of 13.6 per cent of 500 pregnant women (17.5 per cent of 262 primiparae and 9.2 per cent of 238 multiparae). Such figures lead immediately to a consideration of the basic blood sugar curves for the period of pregnancy. Williams and Wills,[2] and Rowe, Gallivan, and Matthews[3] determined that the normal curve in the nonglycosuric pregnant woman has a tendency to fall toward term and rise in the early puerperium. The return to normal occurs within a few weeks postpartum in the majority of patients. Rowe[4] applied the galactose tolerance test to a series of subjects and found that pregnancy lowers the naturally higher tolerance of the mature female to a level approaching the prepubertal curve. Rowe[3] and his co-workers found that the recovery of normal adult tolerance is slow, but that it usually develops before the end of lactation. Williams and Wills[2] found the blood sugar curves of glycosuric pregnant women to be elevated but not diabetic. The curves present an exaggerated "lag." Their figure for symptomless glycosuria among 640 pregnant women on a routine diet was 5.4 per cent. The sugar excreted in the urine is almost invariably glucose during the course of pregnancy; but lactose is found in the urine quite frequently during the period of mammary engorgement early in lactation.

The presence of sugar in the urine at any time, but especially in the course of pregnancy, imposes an immediate obligation upon the clinician to establish its significance. On this basis it is possible to make the following division:

whether any severe diabetic survived pregnancy in the pre-insulin period; but it is beside the point to discuss the viewpoint of that era except for perspective. Duncan,[10] Parsons[13] and Williams,[14] among others, have painted a pessimistic picture of the maternal and fetal risks of that earlier period.

A clinical observation of increased sugar tolerance in the diabetic mother in the later months of pregnancy has a distinct bearing on the management of these patients. In a diabetic reported by Parsons, Randall and Wilder[13] the dosage of insulin had to be dropped from 60 to 40 units in the sixth month of pregnancy and at the eighth month hypoglycemia occurred on 35 units. The standard diet used for two years was ultimately borne without insulin for a few days. With the cessation of lactation, however, the blood sugar rose and glycosuria ensued. Interestingly, the tolerance to sugar appeared improved thereafter by reason of the smaller dosage of insulin required to effect control. Similar experiences have been reported by Stander and Peckham,[15] Lawrence,[16] and Gray and Feemster.[17] Since this improvement in the maternal sugar metabolism always occurs late in pregnancy, if at all, the inference of a supplementary insulin supply from the fetal islands of Langerhans has been generally accepted. Gray and Feemster[17] gave the most convincing direct proof of such a compensatory change in the demonstration of twenty-four times the amount of island of Langerhans tissue in the four-day-old child of a diabetic mother as compared with the normal. They pointed out the danger of hypoglycemia in the child born of such a parent, to compensate for whose insulin deficiency hyperplasia of the islands of Langerhans may have occurred in the child. Lawrence[16] hypothesized that twin pregnancy might well afford a further increased insulin supply to the mother.

From the experimental standpoint, Carlson and his co-workers[18, 19, 20] approached this problem in the pregnant bitch before the isolation of insulin. On total extirpation of the pancreas in nonpregnant bitches death resulted in seven to twelve hours; whereas if the bitches were pregnant, neither hyperglycemia nor glycosuria occurred after complete removal of the pancreas as long as the fetuses remained alive and the placental connections intact. With labor came a rise of blood sugar and after delivery the typical picture of diabetes mellitus ensued. Pack and Barber[21] approached the problem of a fetal source of insulin for maternal metabolism by a different method. The abdomens of pregnant goats were opened and with especial precautions insulin was injected directly into the fetuses. Hypoglycemia resulted in the mother, indicating a transfetal and transplacental source of the added maternal supply of insulin.

Not only does the existence of pregnancy in a diabetic impose a serious burden upon sugar metabolism and all that this implies, but the danger of infection is greatly increased, and Liepmann[21] has described metritis dissecans as a complication of diabetes in pregnancy. The tendency to overgrowth of the fetus has been noted by Duncan,[10] Springer,[22] Lambie[5] and many other clinicians. The hyperglycemia of the mother affords an added source of nutrition to the fetus. Naturally this excessive size adds greatly to the difficulty of labor. Occasionally a child suffering from fulminating diabetes is born of a diabetic mother. In the case reported by Ambard and his associates[23] marked pancreatic lesions were found at necropsy in the infant born of a mother with diabetes.

be accurately made and the dangers both of hypoglycemia and of ketosis averted. The desperate cases of coma in inadequately controlled diabetes complicating pregnancy were formerly universally fatal. With insulin and appropriate supportive measures, the mother may usually be saved, but the infant is either stillborn or does not long survive. Reveno[22] reported one of the first cases of this type after the introduction of insulin. His patient had experienced four or five previous miscarriages at two to three months. When she entered the hospital she was precomatose; the blood sugar was 444 mg. per 100 cc.; acetone and diacetic acid were demonstrable in the urine. Heroic doses of insulin, sodium bicarbonate and forced fluids controlled the situation. The premature infant died in sixteen hours. After delivery of the infant the mother underwent a decided change for the better and was shortly stabilized on small doses of insulin. In no other complication of pregnancy is eternal vigilance more essentially the price of safety to the patient. Bearing in mind the tendency to overweight in the fetus, lower caloric intake for the mother and the induction of labor somewhat before calculated term should appreciably reduce the risk. Cesarean section may be advisable when the strain of labor seems prohibitive by reason of the precarious condition of the patient.

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in this condition. The pigmentation is much more general and darker brown than in pregnancy. Black freckles form a striking contrast to the general bronzing, and the pigmentation of the mucous membranes of the mouth is an almost constant finding. The arterial hypotension, low blood sugar, depressed basal metabolic rate and calcification of the suprarenal glands, as evidenced by roentgenological study, are points of further diagnostic significance.

The prognosis for the mother has been almost uniformly grave in the past. Fitz-Patrick[1] reported that 5 of the 12 patients in his collected series had succumbed during pregnancy, but that there had been no apparent effect upon the course of Addison's disease in those surviving childbearing. Abortion occurred only in the very advanced cases. Shaw[3] reports the apparent improvement of a patient with Addison's disease in the later months of pregnancy, with death shortly after delivery. This experience suggests a possible parallelism with diabetes mellitus in the fetal supply of a deficient internal secretion. Such an auxiliary function could only be expected after the third fetal month when the corticomedullary differentiation occurs.

The Muirhead regimen of substitution therapy of adrenalin and suprarenal gland substance by the oral, rectal and subcutaneous routes[4] has given a measure of relief in certain cases; and the work of Hartman and his co-workers,[5, 6] and of Swingle and Pfiffner,[7, 8] in the isolation of a cortical hormone from the suprarenal glands has opened the way for the ultimate clinical control of the serious and commonly fatal crises of Addison's disease. Granting an inability to meet the underlying pathology by any form of substitution therapy, the remote prognosis will be established by the etiologic background of the disease. For the purposes of the present discussion of the coincidence of Addison's disease and pregnancy, early clinical success[9] with the cortical hormone would seem to justify a favorable prognosis for the term of pregnancy at least.

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Month of pregnancy	Minutes
2	17
3	24
4	20
5	29
6	33
7	40
8	47
9	45
Puerperium	
1	41
2	20

Fåhraeus found a marked parallelism between the increased percentage of serum globulin and fibrinogen on one hand, and the sinking velocity on the other. Mathieu and his co-workers[7] found practically the same curve as Fåhraeus; but in their series the postpartum fall to normal occurred before the end of the fourth week if the case were uncomplicated. Dodds and Telfer[8] concluded that the sedimentation time offered no assistance in the differential diagnosis of abscess, ectopic pregnancy and malignancy, since the values were high in all, as well as in pregnancy.

Anemia of Pregnancy and the Puerperium.—As determined by Bland and his coworkers[9] a majority of women (56.7 per cent in a series of 1000) show some degree of anemia in the last trimester of pregnancy. Increasing objection is being voiced to the application of the term "physiologic" to this manifestly pathologic state. The earliest studies upon the subject were made by Channing[10]; but the confused state of the knowledge of blood dyscrasias at that time (1842) led to the inclusion of many related and unrelated conditions. General disagreement is expressed with his inclusion of anemias of obviously infectious origin. Then, too, it must be apparent to even the most casual observer that the causes of anemia in pregnancy and the puerperium must be quite varied. On this basis many clinical divisions have been arranged. The most useful of these were made by Osler[11] and by Alder.[12]

Osler's classification follows:

I. Anemia from postpartum hemorrhage:
   (a) Rapidly fatal, profuse.
   (b) Repeated, small.
II. Severe anemia of pregnancy (chlorotic in type, which may pass on to a grave, fatal form).
III. Postpartum anemia (progressive and commonly fatal).
IV. Acute anemia of postpartum sepsis (hemolytic in type).

In developing these groups, characteristic cases were cited by Osler[11] and certain details of the clinical aspects of the several orders demand further elucidation. Posthemorrhagic and septic anemias are of such common occurrence as to necessitate no special consideration in this relation; but anemias of groups II and III are among the enigmas of medicine. Group II, the severe anemia of pregnancy, is of the chlorotic type and Strauss[13] felt that it probably depends upon a faulty assimilation of iron in the absence of free hydrochloric acid in the stomach; but other factors are doubtless operative in its further development. The hemoglobin is reduced dispro-

may be indicated. Strauss[12] and others have reported excellent results from the use of iron in the chlorotic anemias of pregnancy. The doses now prescribed ordinarily exceed 1 Gm. of Blaud's mass four times a day. If possible this dose should be given six times a day. At the same time when the free hydrochloric acid of the gastric juice is deficient or absent, diluted hydrochloric acid should be given in 4 to 6 cc. doses three times a day at meals, well diluted in water or buttermilk. The diet should be abundant in green and leafy vegetables, red meats and liver. The general hygienic care of the patient must not be neglected. Occasionally, transfusions are life-saving in the advanced or neglected case, but ordinarily they are not required to meet the need of the average anemia of this type.

As to the grave megaloblastic anemia of pregnancy and the puerperium, the response to transfusions, repeated if necessary, has been so prompt and regular as to constitute almost specific therapy. Channing[9] thus argued many years ago: "The question of transfusion has often occurred to me. But of what possible benefit would be such a supply of blood? What might not the effect be of filling almost empty vessels with a fluid so unlike that which already circulates in them, and which their own functions have produced? In a disease so fatal some risk might be incurred. But is transfusion an operation which our present knowledge of it would authorize? If safe in itself, however, might not time be gained by the operation, for such functional changes to occur as would supply healthful blood?" Certainly the French viewpoint as voiced by Aubertin[21] for the prompt evacuation of the uterus is not justified, particularly since there is no evidence that delivery relieves the condition. In fact the time of onset of the anemia is not infrequently puerperal.[16] Reist[22] reported unfortunate results from intervention in this type of anemia. In his judgment transfusion has reduced the mortality of 50 per cent as quoted by Esch[11] to a minimum. Certainly the latter's figures must be revised. The Minot-Murphy regimen[23] for the treatment of pernicious anemia was early applied to this group of cases with successful results. Deschamps and Froyez[24] among others have reported on this phase of therapy. Equally successful have been the responses to liver extract.[25, 17] In fact in certain cases the pregnancy has been carried to term under this form of treatment.[25] With liver therapy reticulocyte showers may be expected in the peripheral blood whenever the initial level of erythrocytes is below 2.5 millions, and their numbers will be in inverse proportion to this initial erythrocyte count. The average dosage of liver is 250 Gm. a day. It may be taken raw, well minced and concealed in tomato or fruit juice, or it may be prepared by cooking in one of many preferred styles. The extract of choice is Eli Lilly's 343, a vial of which represents 100 Gm. of fresh liver. The ordinary dose of the liver extract is 1 vial three times a day (equivalent to 300 Gm. of whole liver). Valentine's liver extract E-29 and a number of other liver products are equally potent. Refined liver extracts are now available for intravenous and intramuscular use. In all probability ventriculin[26] will prove as effective as liver in the treatment of this type of anemia. It is recommended in doses of 10 Gm. a day for each million deficiency in erythrocytes.

Splenic Anemia.—This condition as a complication of pregnancy has been described very rarely in the literature. In 1930 Hesseltine[27] collected 3 cases of Banti's disease and added a fourth of his own. In his account he

the leukemic infiltration. Wallgren[34] in reporting a case in his own practice and reviewing the literature related that up to that time (1921) three of four fetuses had died but that the fourth had survived and remained entirely healthy. Peterson[35] also reported a normal baby from a mother suffering from acute leukemia. Sanger,[36] in a scholarly discussion, advanced the customary escape of the child as proof of the absence of a transmission of the maternal blood dyscrasia to the fetus. Prematurity and maceration of the fetus are not uncommon.[37, 38] The mother survived childbearing in only two instances of the twelve in Kosmak's series[32] and viable children lived only a few days to five months. Treatment avails nothing in acute leukemia and survival casts serious doubt upon the diagnosis from the present viewpoint.

Chronic Leukemia.—Most of the cases in the literature of chronic leukemia complicating pregnancy have been of the myelocytic type. The splenomegaly attendant upon this form of leukemia particularly adds to the mechanical load of pregnancy. Herman[39] emphasized this point and stated that all of the symptoms of leukemia are aggravated by pregnancy. His review of the literature, which at that time (1901) included 12 cases, led him to conclude that there is a definite tendency to abortion or premature delivery in these cases. Maternal death not infrequently occurred soon after delivery; but in certain instances improvement attended the puerperium. Schröder[40] concurred in this experience. This temporary remission may be entirely subjective and dependent upon the decrease in intra-abdominal pressure.

Before introduction of the roentgen-ray and radium in the treatment of chronic leukemia, Herman[39] urged therapeutic abortion or the induction of labor. More recently (1930) Neumann[41] advocated the interruption of pregnancy and sterilization by radium in event of the appearance of dyspnea in chronic myelocytic leukemia. Hausam[42] and Ridder[43] cited cases in which the roentgen-ray had held the leukemic situation in control. In the latter's case the mother was delivered of a normal child. Radium therapy with heavy initial doses was favored by Bower and Clark[44] who in 1925 reviewed the subject. The cases including their own totalled 17 at that time. The suggested efficacy of Fowler's solution in a case of leukemia termed acute by Greene[45] recalls the recent observation, by Forkner and Scott,[46] of the utility of this preparation in chronic myelocytic leukemia. Doses of 5 minims of Fowler's solution increased to 15 minims three times a day may prove valuable.

Hodgkin's Disease.—Gemmell[47] reported an instance of Hodgkin's disease in which pregnancy occurred three times after the discovery of the lymphadenopathy. Two deliveries were normal, as were also the babies; in the other an intercurrent attack of influenza brought about a spontaneous abortion. Three years and a half had elapsed since the onset of the trouble which had been kept in check by radiation. Gemmell cited the case reported by Davies and stated that advice was ordinarily given to terminate pregnancy if Hodgkin's disease were determined early in the course. With modern methods of roentgen-ray and radium therapy such a radical plan would seem highly inadvisable.

Purpura Haemorrhagica.—There is little evidence that pregnancy predisposes to purpura haemorrhagica; but the clinical manifestations of purpura in spontaneous hemorrhages, reduced platelets, prolonged bleeding time,

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labor constituted a serious risk to the mother in that the mortality in this group was 41 per cent, as compared with 16 per cent among those in whom the pregnancy was not interrupted.

Bland[2] and other observers concur in the opinion that pregnant women have an increased susceptibility to influenza and that a higher mortality attends its occurrence in this group. Mild attacks of the disease carry little risk either to the mother or to the offspring. Labor is apt to be prolonged and tedious in contrast to the inconspicuous pain that frequently attends abortion. Farrar[3] has urged that therapeutic abortion or the induction of labor can effect no benefit but may aggravate the general condition.

Welz[6] noted that the fate of the fetus was intimately linked with the general condition of the mother. He urged that so dangerous was the toxemia to the fetus that all ends must be directed to combatting the same in the mother. A further well-recognized hazard to the fetal survival lies in the possibility of *transplacental infection*. Abt,[9] for example, related the case of a child dying from hemorrhagic bronchopneumonia three days after birth in which the mother suffered from influenza and went into labor prematurely. At birth the child was grayish blue in color and there were many râles in both lungs ten minutes after delivery. A septic endocarditis of the tricuspid valve, cloudy swelling of the parenchymatous organs and a widespread hemorrhagic bronchopneumonia were established at necropsy. Cultures of the lungs, spleen and other organs revealed streptococci and staphylococci (albus and aureus types). A similar experience occurring in the services of Drs. E. F. Schneiders and H. K. Tenney[10] at the St. Mary's Hospital, Madison, Wisconsin, was confirmed by roentgenological and necropsy studies.

The management of influenza complicating pregnancy is primarily prophylactic. Failing to prevent the infection, no biological product is available for its treatment. The general measures in use for symptomatic treatment may be utilized in the pregnant patient. Because of the serious dangers of anoxemia to fetal integrity and life the early and continuous exhibition of oxygen is advised.

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Lobar Pneumonia.—Pneumonia of any type is a dangerous complication in pregnancy. Lobar pneumonia brings in its train the burden of toxemia,

each year in this country alone, arrests the attention. The magnitude of this problem obviously cannot be overemphasized and its solution in the individual case must confront every practitioner from time to time. Yet singularly there is a wide divergence of opinion both in precept and in practice as to the proper management of these complicating conditions. By general admission the question is a highly individualized one; yet certain generalities may be accepted as fairly universally established.

The consensus among students of the subject is strongly opposed to matrimony in the presence of active pulmonary tuberculosis. Arbitrary intervals of two to three years of complete quiescence are suggested as fair proof of the physical eligibility of the tuberculous woman for marriage.[2] This question will receive more adequate discussion in Chapter LV; but it should be emphasized that a period of marital adjustment should be advised before conception occurs and the strain of gestation is undertaken.[3] Such statements presuppose the willingness and ability of the principals to cooperate. In such instances the problem is simplified; but much more grave are those cases in which pregnancy under or against advice is attended by the reactivation of an apparently quiescent tuberculous process or the extension of an active pulmonary lesion. In a minority of tuberculous patients the history of an actual inception of the process can be traced to pregnancy;[3] but there is ample clinical evidence to support the opinion that the strain of pregnancy and of lactation add greatly to the risk of tuberculosis.

In the event that the pregnant woman be proven actively tuberculous, the pendulum of obstetrical management has swung widely in the past generation from the German plan of immediate therapeutic abortion to the French idea, as expressed by Bernard,[4] "Quand on est tuberculeuse, ne pas devenir enceinte; mais quand une tuberculeuse est enceinte, il n'est pas certain qu'elle ait avantage à interrompre sa gestation." Apparently guided largely by the observations of Bridgman and Norwood,[5] Williams[6] has taken a most conservative viewpoint of nonintervention. These observers,[5] while admitting that pregnancy frequently leads to a breakdown in the tuberculous subject, believed that the artificial termination of pregnancy is not warranted at any stage. While 5 of the 9 tuberculous women upon whom a therapeutic abortion was performed died within a year's time, the series is altogether too abbreviated to carry conviction as to the wisdom of nonintervention. Forssner, Sundell and Kjellin[7] felt that a knowledge of the pathogenesis of the tuberculous process is more important than statistics. In their judgment therapeutic abortion is contraindicated except in rare instances. Their figures, involving large numbers of pregnant women (341) and nonpregnant controls (396) with tuberculosis over a period of a year, show no appreciable or constant differences. Like groups, numbering 299 and 359, respectively, closely coincided in results after two years. Dumarest and Brette[8] pointed out the great risk of therapeutic abortion to the mother and added that two were frequently sacrificed in the forlorn hope of saving the mother.

Against this array of expert opinion, which might be multiplied many times, may be called a number of equally recognized authorities who advise therapeutic abortion more freely under well-controlled conditions. Among these Trembley[9] took the most radical viewpoint. By reason of his experience at Saranac he felt that not only is pregnancy an important factor in the advance or spread of the process, but also that not infrequently tuberculosis

seriously taxed. Norris and Landis[illegible] have pointed out that tuberculosis even in the advanced stages does not preclude conception. Furthermore, after conception there is little tendency to abortion, miscarriage or premature labor, except in the far advanced cases. Hence the responsibility for interruption of the pregnancy falls upon the physician. Divorced from all religious and emotional influences the question confronting the medical man is the preservation of human life. If fetal life can be conserved with maternal safety, so much the better; but if the possible survival of an unborn child is obtainable only by the sacrifice of a mother, medical practice can never condone the judgment of the attending physician who signs the death-warrant of a woman through permitting her to bear a child at the price of her own life.

Briefly stated, pregnancy may be permitted in tuberculous patients who have had a period of two or more years' complete clinical quiescence. Under such circumstances the temperature curve, pulse, weight and leukocytic formula should be observed throughout the period of pregnancy for the earliest evidence of activation. The physical examination and periodic roentgenograms of the chest will serve as further checks on the preexistent status. Should there develop any evidence of activity, or if activity be established for the first time early in pregnancy, the patient should be kept at rest in bed, with careful observation of the physical state (with especial reference to the lungs), temperature, pulse and weight, and close study of the leukocytic formula. Medlar[15] showed that the trend of the differential leukocytic count is an excellent measure of the bodily resistance to tuberculosis. Elevation of the lymphocytes with corresponding fall of the polymorphonuclear neutrophiles indicates a rise of bodily resistance, whereas a rise of the neutrophiles and the mononuclears portends an ascendancy of the infection. Artificial pneumothorax has been advocated by the French particularly[3, 17] and has been attended by a measure of success. On the basis of these results, the minor surgical measures in the treatment of pulmonary tuberculosis, phrenic block, phrenicectomy, scaleniotomy and intercostal neurectomy, may ultimately find a place in the care of this complication of pregnancy. If all measures fail to stay the advance of the tuberculous process, therapeutic abortion must not be long delayed. Before the fifth month of pregnancy it may be resorted to as soon as the gravity of the maternal situation is fixed, either by the toxemia of a moderately advanced to advanced lesion or by the progression of a minimal lesion. After the fifth month the danger of intervention advances apace and, as previously stated, the risk of normal delivery is no greater than that of therapeutic abortion. Accordingly, in the late months of pregnancy, regardless of the stage or the state of the pulmonary process, nonintervention is the rule. In rare instances a late abortion may appear advisable if survival of the mother depends upon release from the strain of pregnancy; ordinarily it is much safer to induce labor prematurely in the hope of delivering a normal child, thus avoiding the protracted course of labor common to this group of patients.

The occurrence of placental and fetal tuberculosis is generally recognized and must play a part in the decision as to the conduct of pregnancy. Friedmann[13] advanced experimental evidence that the spermatozoa may carry tubercle bacilli to the embryo without the intermediation of the mother. This circumstance can have only theoretic significance, since the relative

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CHAPTER IX

CHAPTER X

CHAPTER XI

SECTION III

MORPHOLOGY AND PHYSIOLOGY OF PREGNANCY

CHAPTER XII

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CHAPTER XVII

CHAPTER XVIII

CHAPTER XIX

branch of the broad specialties of gynecology and obstetrics, medicine, embryology, pediatrics, pathology, radiology and radiotherapy, and endocrinology. They are men of reputation, sane in their views, comprehensive in practice, conservative in judgment. To insure proper coordination of material, many conferences were held with the editor by authors who were writing on closely allied subjects.

Dr. Arthur H. Curtis has accepted the difficult assignment of editing these volumes. He has proved that he is supremely fitted for his task. He is a writer of force, an impelling teacher, a practical research worker, and, of most importance, an independent practitioner of clinical gynecology and obstetrics whose paramount interest it is to benefit his patients.

His vision in planning this work goes beyond the range of an ephemeral production. He conceived the idea that there should be a comprehensive history to portray "what America has to tell about obstetrics and diseases of women"—anatomy and physiology, accepted methods of preventive medicine, diagnosis, personal management, therapeutic treatment, surgical technic, and follow-up. Though creditable volumes by individual authors were written before gynecology and obstetrics were refined into specialties of a specialty, no one man can now prepare a comprehensive work on either of these branches any more than one individual can edit a modern journal of medicine.

Dr. Curtis says: "It is planned to publish a new edition every five to eight years, the work of former authors being reedited by them or their names retained and their contributions altered and rejuvenated by those most worthy to follow in their footsteps (as determined by the author, his confrères, and the editor). A new editor is to be chosen from time to time to carry on the work." We, his followers, are aware of his vision and of his wisdom, and do not doubt that this first edition will meet with an enthusiastic reception. Through the plan of organizing for permanency, the reputation of authority will be preserved, and each revision will contain the consensus of opinion and practice of the foremost practical authorities. Thus this product will become the encyclopedia of obstetrics and gynecology, and of necessity will have a place not only in the library of every up-to-date practitioner of a specialty, but also in every reference library of medicine.

This work will be of interest and profit to every obstetrician and gynecologist. It should be an inspiration to the specialist, a guide to the independent practitioner, a model for teachers, and a comprehensive text-book for advanced students. General specialists will be convinced that a high type of specialization is necessary to treat diseases peculiar to women; and that obstetrics, an allied subject, also requires a special type of mind and temperament for its successful management. These volumes should be carefully perused by the general surgeon, who, as a rule, is as far removed from being a gynecologist as he is from being an obstetrician. Obstetrics and gynecology are more than mere branches of surgery, and this fact is unobtrusively made plain. The sympathetic management of diseases of women and of obstetrics is at least as important as the surgical procedures involved, and the surgery is of a special type.

From a veteran's standpoint, a few of the many subjects presented herein are of rare interest, viz., "Gonorrheal Disease in Female Children"; "The 'Cellulitis Group' of Pelvic Infections"; "Syphilis"; "Dysmenorrhea,"

HISTORICAL

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DEVELOPMENT OF CLINICAL MIDWIFERY IN GREAT BRITAIN

In the historical section of *An Introduction to the Practice of Midwifery*, Thomas Denman notes that one of the earliest English authors on midwifery was Bartholomeus Glanvil[1] (fl. 1360) a Franciscan Friar, who lived in the time of Edward III (1312-1377). His book, *Bartholomeus de Proprietatibus Rerum*[2] printed by Caxton, is an encyclopedia of knowledge, and contains a chapter "de obstetrice." Denman notes that this chapter has little to do with midwifery, but relates mostly to the management of the child. A translation of the book by John Trevisa[3] (1326-1412) was printed by Wynkyn de Worde (d. 1534) in 1397, other editions appearing at later dates.

An early—probably the earliest—work on midwifery in English is the manuscript known as Sloan manuscript No. 2463. The description of this valuable document by Aveling[4] is replete with interest. Aveling identifies the manuscript as fifteenth century and as following Rogerius of Parma[5] (c. 1210) in content, inasmuch as the arrangement of the chapters is identical with the 1490 published edition of Rogerius and certain portions are literally translated. Sixteen "manners" are described in which the child may present: for example:

". . . The fifte maner ayenst kynde is if the child profereth his handis first forth and his hede be turned ayen [illegible] . . . . The seventh is yf the child come forth [illegible] hym forth [illegible] and his fete so as they [illegible] hym forth."

Aveling says:

"It will be observed that the midwife's duty consisted principally in showing the child back again when it did not present kindly. If this did not answer, she was to use therapeutic measures."

[1] Bartholomeus Glanvil was of the family of the Earl of Suffolk. He studied at Oxford, Paris and Rome.

[2] *Incipit prohemium de proprietatibus rerum, fratris Bartholomei Anglici de ordine fratrum minorum*, was probably printed at Basle about 1470. The same work was published in London, 1535, probably translated by J. Trevisa.

[3] John de Trevisa was a Cornish divine and is said to have published an edition of the Bible.

[4] *An account of the earliest English work on midwifery and the diseases of women. Obstetrical Journal of Great Britain and Ireland*, vol. II, 1874, p. 73.

[5] The original *Practica chirurgiae* written by Rogerius of Parma exists only in manuscript form, but it was copied by Rolando Capelluti about 1250 and later printed. The work formed the basis of medieval Italian surgery.

Eucharius Roesslin, the elder (d. 1526), was a physician who resided in Worms and later in Frankfort. He published a book on midwifery in 1513,[1] his *Rosegarten*, which became the accepted guide for midwives and physicians for nearly a century. Its publication in several languages made its precepts available wherever books were read. As may be understood the instructions set forth in the volume are simple and direct, nearly all the important positions of the fetus are discussed, and the manner of delivery is described. The work was a timely production.

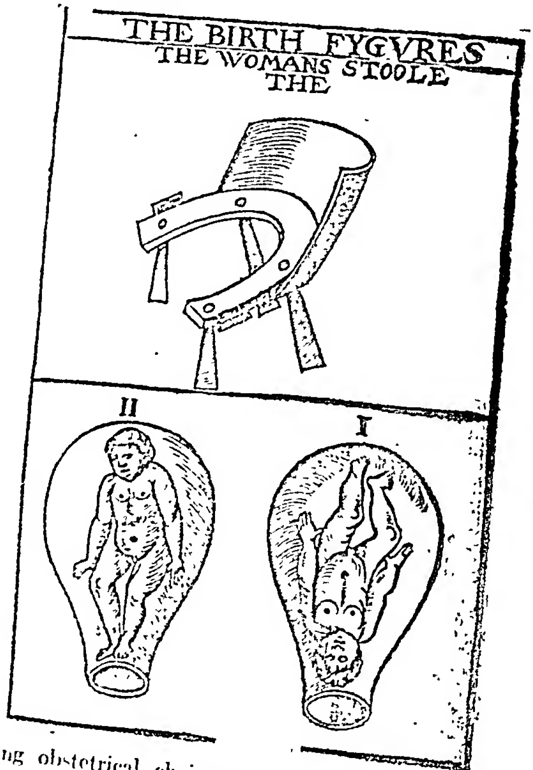


Fig. 2.—Plate showing obstetrical chair and presentations of fetus. From the 1560 edition of *The Byrth of Mankynde*, by Thomas Raynalde.

From the manuscript of Dr. Percivall Willughby[2] (1596–1685) (who first resided at Derby and afterward in London), Thomas Denman gives the

[1] Facsimile edition published in 1910 by Carl Kuhn, Munich.

[2] Dr. Percivall Willughby, sixth son of Sir Percivall Willughby, knt., of Wollaton Hall, Nottinghamshire, where he was born, was educated at Trowbridge, Rugby, Eton, and Oxford. B. A., 1621. In 1619 he was articled for seven years to Feamer van Otten. Soon after he commenced practice for himself, and in 1631 settled in Derby. In 1640 he was admitted an extra licentiate of the Royal College of Physicians. In 1655 he removed to London, but in 1660 returned to Derby, where he resumed his practice as a physician, enjoying a high reputation throughout the neighborhood for his skill in obstetrical operations. He deprecated the use of the crotchet, and endeavored to overcome all difficulties by turning. The earliest copy of his work is a closely written quarto, entitled *Dni Willoughbei, Derbiensis, De Puerperio Tractatus*, in the British Museum, Sloane MS. 529. The second, an amplification of this, and referred to by Dr. Denman in his *Practice of Midwifery*, was then in the possession of his friend, Dr. Thomas Kirkland; while the third and greatly enlarged edition consisted of two exquisitely written copies in Latin and in English, which were quite recently the property of the late Dr. J. H. Aveling.

consists of seventeen books and contains the writings of Nicholas Culpeper[1] (1616–1654), physician and astrologer; Abdiah Cole (1610?–1670?), doctor of physick; William Rowland (fl. 1668), physician; Lazarus Riverius, counsellor and physician to the King of France; and John Fernelius[2] (1497–1558). The fifteenth book is devoted to the diseases of women, and in the preface the author says:

"Those are called Womens Diseases which are proper to them only, and come from the defect of that part which is distinct in them from men, viz: the Womb; of which Democritus in his Letter to Hypocrates said, That it was the cause of six hundred miseries, and innumerable Calamities. But we to lay down those Diseases of the Womb which are most usual, will divide them thus: Some come from the Vessels, and some from the Body of the Womb or Cavity; others are in respect of its chief and not least act of Generation. From the distemper of the Vessels of the Womb, and the preternatural causes, come Chlorosis or Green Sickness, stoppage of the Terms, immoderate Flux, the Whites, Rage of the Womb, and the Mother. In the Cavity of the Womb are, Inflammations, Ulcers, Schirrhus, Cancer, Gangrene, Dropsie coming forth, and shutting up thereof: These may hinder Generation but by accident. The Diseases which are in respect of Conception, Breeding and Bringing forth, are Barrenness, acute and Chronical Diseases of Women with Child, Abortion, difficult bringing forth, dead Child, Secundine retained; immoderate flux, or suppression of blood, and the acute Diseases of Women in Child-bed. All which Diseases we will speak of in as few words as the dignity of the matter will permit."

In discussing difficult births the author directs that all causes of delay are to be removed, though no mention is made of the causes nor is the method of their removal prescribed. There is, however, the usual reliance upon drug therapy:

"Such Medicines as further the Birth are Methodically to be administred. . . . Among the more effectual sort of Medicaments are numbred Oyl of Amber, Oyl of Cinnamon and extract of Saffron, which do in a little quantity work much . . . Sneezing may be provoked by the following Powder. Take white Hellebore half a dram: Long Pepper one scruple, Castorium five grains. Make all into a Powder, and blow thereof the quantity of a Pease. . . . Also hard Travail may be holpen not only by these inward Medicines prescribed, but likewise by outward. Let the Midwife therefore frequently annoint the womb of the Childing-woman with Oyls of Lillies, sweet Almonds, Lin-seed, and suchlike. . . . If the child begin to come forth in a disorderly manner, as by putting out one Foot, one Hand, or any other way, the Midwife must no ways receive it on that manner, but thrust it into the Womb again, and compose it to a right and natural posture or form of Egress. Which must be done by laying the Childing woman on her back in the bed, with her head somewhat low, and her buttocks high: and then gently pressing her belly towards the short ribs, and thrusting the child into the womb. Afterward let the Midwife endeavour to put the child into a right posture for coming out by an artificial hand, procuring that the child turn its face towards the mothers back, and its buttocks and thighs let her lift up towards the mothers navel, and so hasten the same unto a Natural manner of coming forth."

Should the child be dead and after medicines have failed:

". . . we must implore the Chyrurgeons aid. Who may pull it out, either by Instruments, as Paulus Aegineta (625–690) describes the manner, or only help of the hand, as is taught by Carolus Stephanus (1504–1564), Banhine (1560–1624), and others; all which are diligently transcribed by Schenkius (1530–1598) and Sennertus (1572–1637)."

[1] Nicholas Culpeper published a translation of the College of Physicians' *Pharmacopoeia*, for which he was virulently lampooned, in 1649; *The English Physician Enlarged* in 1653.

[2] John Fernelius (Jean Fernel) studied in Paris at the Faculty of Medicine. His chief work, *Medicina* (1544), was later republished with many additions under the title *Universa Medicina*.

Fig. 4.—William Harvey. From the original portrait by C. Jansen in the possession of the Royal Society. (From the author's collection.)

ANATOMICAL EXERCITATIONS,

Concerning the

GENERATION

Of Living Creatures:

To which are added Particular Difcourfes, of *Births*, and of *Conceptions*, &c.

By *WILLIAM HARVEY*, Doctor of *Phyfick*, and Profeffor of *Anatomy*, and *Chirurgery*, in the COLLEDGE of Phyfitians of *LONDON*.

LONDON,

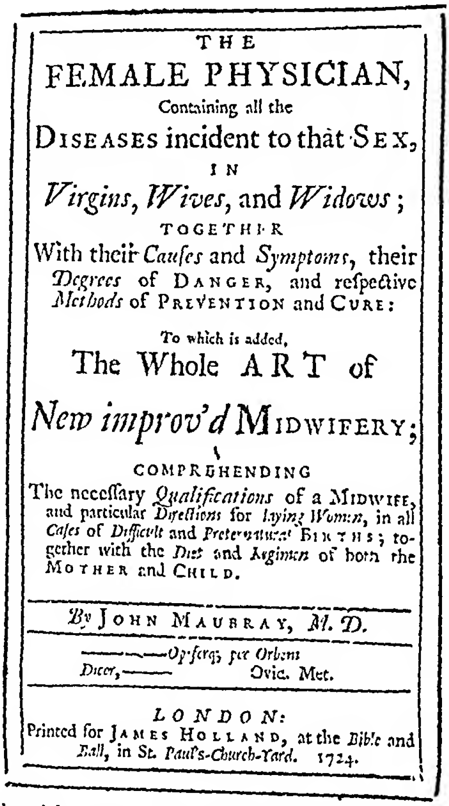
Printed by *James Young*, for *Octavian Pulleyn*, and are to be fold at his Shop at the Sign of the Rofe in St. *Pauls* Church-yard. 1653.

Fig. 5.—Facsimile of the title page of *Anatomical Exercitations*, by William Harvey, London, 1653.

"If we consider the many *occult Qualities*, and *secret Influences* of celestial Bodies, besides these *three* which are manifest to us, namely, *Heat, Light* and *Motion*, we shall readily and rationally agree with *Astrologers*, as well as *Philosophers*, in this Point; that the *celestial Bodies* concur with other *natural Causes*, in the regular *Procession* of all the different Steps of the *Conformation* and *Constitution* of human CONCEPTION."

Because of the numerous responsibilities which devolve upon the professors of the art of midwifery, Maubray notes that women have finally been taught

". . . to lay aside all *childish Bashfulness* and *imaginary Modesty*, in order to secure their *Own* and their *Childrens* Safety, by inviting the *Assistance* of *both SEXES*."


THE
FEMALE PHYSICIAN,
Containing all the
DISEASES incident to that SEX,
IN
Virgins, Wives, and *Widows*;
TOGETHER
With their *Caufes* and *Symptoms*, their *Degrees* of DANGER, and refpective *Methods* of PREVENTION and CURE:
To which is added,
The Whole ART of
New improv'd MIDWIFERY;
COMPREHENDING
The neceffary *Qualifications* of a MIDWIFE, and particular *Directions* for *Lying-Women*, in all *Cafes* of *Difficult* and *Preternatural* BIRTHS; together with the *Diet* and *Regimen* of both the MOTHER and CHILD.

By JOHN MAUBRAY, *M. D.*

——*Opiferq; per Orbem Dicor*,—— Ovid. Met.

LONDON:
Printed for JAMES HOLLAND, at the *Bible* and *Ball*, in St. *Paul's-Church-Yard*. 1724.

Fig. 6.—Facsimile of the title page of *The Female Physician*, by John Maubray, London, 1724.

He believes this is wise because

"MEN . . . being better versed in *Anatomy*, better acquainted with *Physical Helps*, and commonly endued with greater *Presence of Mind*, have been always found readier or discreeter, to devise something more *new*, and to give quicker *Relief* in Cases of *difficult* or *preternatural BIRTHS*, than common *MIDWIVES* generally understand."

He then proposes that instead of calling the male obstetrician a "man-midwife," which he says is a contradiction of terms,

". . . I would call him the ANDRO-BOETHOGYNIST, or *Man-Helper of Woman*."

appears to have been the author that Maubray read with the greatest care. Podalic version is described and follows the procedure we have earlier noted in the writings of Guillemeau, Mauriceau, Bourgeois, and others. Gentle manipulation is emphasized. Without clearly indicating that he understands placenta praevia, he says that when the after-birth falls into the orifice of the womb it "obstructs the passage and timely egress of the infant." The symptom of hemorrhage is noted, in which event, Maubray says "the mother and child are imminently endangered." Rather than perforate the after-birth with an instrument or by means of the fingers in order to perform manual delivery, Maubray instructs that the safest and shortest way is first to extract the placenta after which the child may be grasped by the heels and delivery effected.

> ". . . in this critical *Condition*, the *BIRTH* must immediately follow the *SECUNDINE*, without the Loss of one Moment's Time, and *that* especially for stopping the *Floodings*, which would otherways not only soon suffocate the weak INFANT, but also in a short Space of Time effect the certain *Death* of the tender MOTHER."

Maubray also calls attention to the danger of hemorrhage in connection with abortion and miscarriage.

One section of the work is devoted to the nurse, her qualifications and duties, the management of the child and diseases of infants. In this discussion Maubray probably refers to tetanus neonatorum when he quotes Arnold de Villanova[1] (1235–1312) and advises that the child soon after birth be given a dose of pulverized coral in a little mother's milk in order to prevent fits "to which newborn children are very subject."

In his chapter on numerous conceptions, he follows the traditions and superstitions of the preceding century. He says that while he could give many instances of the birth of three, four, five or more children at one time, he satisfies himself with quoting the following most remarkable case:

> "*That* of the *Countess Margaret*, Daughter to *Florent IV. Earl of Holland*, and SPOUSE to *Count Herman of Heneberg;* who, on *Good-Friday*, in the Year of our LORD 1276, and of her *Age* 42, brought forth at one BIRTH, 365 INFANTS; whereof 182, are said to have been *Males*, as many *Females*, and the odd one an HERMAPHRODITE: who were all *baptized*, *those* by the Name of JOHN, *these* by that of ELIZABETH, in two *Brazen Dishes*, by *Don William Suffragan Bishop of Treves*. The BASONS are still to be seen in the *Village Church of Losdun*, where all *Strangers* go (on purpose) from the *Hague*, being reckon'd among the great CURIOSITIES of *Holland*."

There is a long chapter on sterility in which he notes the symptoms of melancholia and hysteria and in which he describes many nervous diseases in women as due to "strangulation of the womb."

It is difficult to reconcile the bold effrontery with which Maubray sets forth his own experiences at the birth of *de Suyger* which he calls "the sucker." In describing deformed conceptions, Maubray says that sometimes normal as well as abnormal births are accompanied with

> ". . . . a *Monstrous little Animal*, the likest of any thing in Shape and Size to a MOODIWARP[2]; having a *hooked Snout, fiery sparkling Eyes*, a long *round Neck*, and an acuminated *short Tail*, of an extraordinary *Agility of FEET*. At first *sight* of the World's

[1] Arnold de Villanova studied medicine at Montpellier, taught at Barcelona and was physician to Peter III of Aragon.

[2] Moodiwarp—Scottish dialect for mole.

ningham in stating that the placenta is *always* attached to the fundus whereas Manningham states that it is *usually* attached to the fundus. Manningham added but little to the progress of midwifery although his book proved to be a usable syllabus for his students. Manningham became the fashionable practitioner in midwifery of the day. In 1720 he was elected a fellow of the Royal Society, and in 1721 he was knighted by George I. He played an important rôle in the exposé of Mary Toft, "the rabbet-breeding woman of Godlyman."

In the early part of the eighteenth century great public curiosity was aroused by the report of the case of Mary Toft of Godlyman in the County of Surrey who, as was certified by John Howard, surgeon of Guilford, had

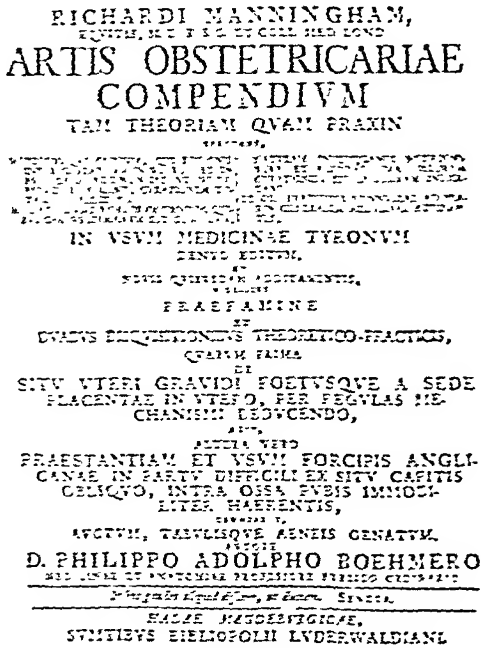

RICHARDI MANNINGHAM,
ARTIS OBSTETRICARIAE
COMPENDIVM
TAM THEORIAM QVAM PRAXIN
IN VSVM MEDICINAE TYRONVM
PRAEFAMINE
DVABVS DISQVISITIONIBVS THEORETICO-PRACTICIS,
QVARVM PRIMA
DE
SITV VTERI GRAVIDI FOETVSQVE A SEDE PLACENTAE IN VTERO, PER REGVLAS MECHANISMI DEDVCENDO,
ALTERA VERO
PRAESTANTIAM ET VSVM FORCIPIS ANGLICANAE IN PARTV DIFFICILI EX SITV CAPITIS OBLIQVO, INTRA OSSA PVBIS IMMOBILITER HAERENTIS,
AVCTVM, TABVLISQVE AENEIS ORNATVM.
D. PHILIPPO ADOLPHO BOEHMERO
HALAE MAGDEBVRGICAE,
SVMTIBVS BIBLIOPOLII LVDERWALDIANI
MDCCXLVI

Fig. 7.—Facsimile of the title page of the 1746 edition of Richard Manningham's *Artis obstetricariae compendium*.

been delivered of a litter of rabbits. The matter created so much consternation that King George I sent his surgeon, Cyriacus Ahlers,[1] to Guilford to make a personal examination and report. Ahlers finally exposed the fraud in a pamphlet published in 1726 (Fig. 8), in which he reports that the lower intestine of one of the rabbits alleged to have been delivered by Surgeon Howard contained pellets of hard excrement composed of small bits of hay, straw, and corn. Just why surgeon Howard maintained this imposture is hard to determine. It is certain that another agent for the king, the anatomist and surgeon, Nathanael St. André[2] (1680–1776), was completely deluded

[1] Cyriacus Ahlers was elected a fellow of the Royal Society March 9, 1727.

[2] Nathanael St. André, anatomist, native of Switzerland, was apprenticed to a surgeon in London, but there is no record of his apprenticeship among the records of the Barber-Surgeons' Company. He was probably an unqualified practitioner, at first protected by court influence. St. André's knowledge of German led George I to appoint him anatomist to the

the one was of four Months growth, and much of the Size of that which I had taken from the Woman, and the other was barely fifteen Days old."

St. André's narrative continues:

"The account she (Mary Toft) further gave of herself, was, that on the 23d of *April* last, as she was weeding in a Field, she saw a Rabbet spring up near her, after which she ran, with another Woman that was at work just by her; this set her a longing for Rabbets, being then, as she thought, five Weeks gone with Child; the other Woman perceiving she was uneasy, charged her with longing for the Rabbet they cou'd not catch, but she deny'd it: soon after another Rabbet sprung up near the same place, which she endeavour'd likewise to catch. The same Night she dreamt that she was in a Field with those two Rabbets in her Lap, and awaked with a sick Fit, which lasted till Morning; from that time, for above three Months, she had a constant and strong desire to eat Rabbets, but being very poor and indigent cou'd not procure any."

Because of St. André's undoubted belief and Ahlers' expressed scepticism in the rabbit-breeding woman, pamphlets were exchanged. In Dr. Ahlers' publication he notes that he is desired by Dr. Steigerthal to

". . . . inform the Publick in his Name, that he all along suspected this whole Affair to be a Fraud and Imposture, and was far from thinking the comparative Anatomy, which is there mention'd by Mr. St. André, any way satisfactory to verifie his Assertions."

To St. André's narrative several affidavits are appended certifying to the truth of the delivery of the rabbits by Surgeon John Howard of Guilford. Mary Toft and her nurse Mary Costen, Elizabeth Helius, Olive Sands, and Thomas Howard, surgeon, submitted sworn statements.

The public clamor relative to the incident did not cease until the rabbit-breeder had been brought to London and the fraud finally exposed by Sir Richard Manningham, John Maubray and others. Manningham's part in the performance was set forth in a pamphlet (1726) entitled *An exact diary of what was observed during a close attendance upon Mary Toft, the pretended rabbet-breeder*. He showed that the fragments of rabbits were pieces of adult and not young rabbits and that the woman was not pregnant. Mary Toft afterward confessed the fraud.

William Giffard (d. 1731).—One of the most attractive of the early eighteenth century books on midwifery is entitled *Cases in Midwifery, Written by the late Mr. William Giffard, Surgeon and Man-midwife* (Fig. 9), Revis'd and Publish'd (edited) by Edward Hody, M. D. and Fellow of the Royal-Society, London, 1734. The book is printed on remarkably fine paper with numerous head and tail pieces, and is dedicated by the editor to Dr. John Hollings[1] (1683?–1739), physician to his Majesty. The dedication, dated July 30, 1733, describes Dr. Giffard (d. 1731) as

"A plain Man, remarkable for an honest, frank Behaviour; and that his Judgment was strong and unprejudic'd, evidently appear'd in the Case of a notorious Impostor in the Year 1726. . . .

"As to his Works, they are wrote after the manner of the famous Monsieur *Mauriceau*; he has herein given us an accurate and impartial Account of the Deliveries of Two hundred and twenty-five Women, which for the most part were attended with a great deal

[1] John Hollings, M. D., Magdalene College, Cambridge, 1710; F. R. S. 1726; F. R. C. P. 1726; Harveian orator, 1734.

them into the Mouth, and by gently pulling here and at the Shoulders, I extricated the Head. After a short Time the Child began to stir, soon after to sob, and then cried out loudly."

As has been pointed out by Spencer[1] this description of Giffard's maneuver should be retained in obstetrical literature inasmuch as it antedates that of Smellie. The delivery of the after-coming head is again described in Case XIII indicating that the procedure was followed as a routine:

"I clapped one Hand flat upon the Breast, and with the other taking hold above the Shoulders, drew towards me, but the Head did not readily follow: I therefore passed my Fingers up to the Child's Mouth, supporting the Breast with my Wrist and Arm, and putting one Finger into the Mouth, and two others upon the Cheeks, I pulled towards me, and at the same time drawing with my other Hand above the Shoulders, brought out the Head."

In a desperate case to which Giffard was summoned, he found the patient in convulsions and at the same time bleeding profusely. The following wise counsel is worthy of note:

"After I had satisfied her Friends of the extreme danger which attended, both her Delivery, and the not attempting it, (a person cannot be too cautious how he acts in such difficulties, to skreen himself from malevolent Tongues) I undertook the Work."

In the case of a presenting arm, Giffard says (Case XLV):

"You are not always obliged to return the Arm when slipped down; for sometimes by so doing you make it more difficult to pass the Hand; the Arm returned often stopping up the inner Orifice: nay, I have sometimes been obliged to bring down an Arm, to make room for my Hand to pass into the Uterus; nor is there any danger in so doing; for generally as the Legs and Thighs advance forwards, the Arm by the turning of the Child is drawn back into the Uterus, and comes out with the Head."

In Case XLVI where a child came footling the midwife was not able to bring it further. In discussing this case Giffard says:

"This Case should be a Caution to Midwives, to send for help in time, when a Child comes Footling, and not to venture (unless they are very skilful) to bring it forwards."

Spencer[2] believes that Giffard's Case CLXXXVI[3] is the first report of a hydatiform mole published in England. The case is entitled "The bringing away of several large Substances, formed from a great number of Hydatides join'd together by a loose Parenchymatous Substance." Giffard says:

"February the 16th, 1730-31. I was sent for into *Petty-France*, to a Gentlewoman whose Husband died about four Months before, she at this time thought herself with Child, and was seiz'd with a Flooding, which she had complained of for several days; but the discharge not being large, she had only made use of Medicines by her Midwife's directions; it now encreasing I was sent for, upon examination, I found that it seized her periodically, and every night her Pulse was quicker and fuller than at any other time. From what I could gather from her discourse, I could not believe that she was with Child, and therefore gave my opinion accordingly. . . . I waited upon her the next day, when she was better; but as her Doctor saw her then, I call'd no more. On the sixth of *March* I was sent for again, she having been seiz'd for several hours with strong Throws, like those preceeding Labour, and a Flooding at this time returned, but not in a large quantity: As

[1] Loc. cit.
[2] Ibid.
[3] Page 437.

One of his cases, that of an ectopic pregnancy, terminated with rupture into the rectum and delivery of the fetus via the anus. The case was autopsied by Mr. Mourse of St. Bartholomew's Hospital and Giffard, in the presence of Dr. Dodd, physician to St. Bartholomew's. The case is No. CLVII in Giffard's collection, and the following autopsy notes are from the report:

"The *Fallopian Tube* on the right side, we traced from the *Fundus Uteri* almost to the *Morsus Diaboli*, where it open'd into, and was confusedly and closely united with a *Sacculus*, immediately to be described. The *Ovary* on this side, together with the *Ligamentum latum*, was dilated into a large *Sacculus* of an irregular form, extending itself behind the *Uterus*, (to the back part of which it adhered) and passing on towards the left side, was connected to that part of the *Colon* that terminates in the *Rectum*, as also to the *Rectum*. In this *Sacculus* we found part of a *Placenta*, and the Remains of the lacerated Membranes; and besides the Aperture of the *Fallopian Tube* mention'd before, there was another about four inches in *Diameter*, into the middle of the *Rectum*: . . ."

Giffard's report, which is illustrated with two excellent copper plates of the pathology found at autopsy, concludes:

"As this Case was communicated to the *Royal Society*, and the parts shewn there, the President, Sir *Hans Sloane*,[1] ordered two Draughts to be taken of them, which I have here annexed."

Giffard may be regarded as the first English obstetrician to publish substantial contributions to clinical midwifery. His wise management of difficult cases, including the careful use of his forceps, marked a distinct advance in the practice of midwifery. From occasional references we learn that his work was known and highly regarded not only throughout England, but in France. He practiced principally in London and environs.

Edmund Chapman (1680?–1756) was a surgeon and midwife who practiced for several years at South Halstead in Essex, before settling in London, where he became after Maubray the second public teacher of midwifery. Spencer[2] says that he was the first person to make known publicly the forceps used by the Chamberlens in his *A Treatise on the Improvement of Midwifery*, the first edition of which was published in 1733 and the second in 1735 (Fig. 11). The first edition does not contain an illustration of his forceps. The dedication of his treatise is addressed to Dr. E. Milward,[3] to whom Chapman says he owes his life and that of his son. In his preface he notes that he had frequently seen, in his twenty-seven years of practice, many fatal mistakes committed by midwives and his great desire is to teach midwifery to those who have made some progress in the art. Midwifery he indicates is

"one of the most noble and useful operations in being and it requires judgment for there is generally one and often two lives snatched as it were from the jaws of death, as in a violent flooding where the Mother or child or both would be inevitably lost in a few minutes without delivery."

He notes further that it must be acknowledged that some being ignorant of turning the child have made frequent use of the hook and knife. He seems to feel that great progress has been made in British midwifery for he says:

[1] Sir Hans Sloane (1660–1753).

[2] Loc. cit.

[3] Edward Milward (1721?–1757), M. D., Cambridge 1741; elected F. R. S. 1742; Fellow Royal College of Physicians 1748; Harveián orator, 1752.

Sir Fielding Ould (1710–1789) was born in Galway, the son of an army officer. On August 16, 1738, he was made a licentiate of the King and Queen's College of Physicians in Ireland. As an example of the attitude of the College toward midwifery, it is worthy of note that in 1760 the College refused the request of the University of Dublin to examine Fielding Ould for the degree of Bachelor of Physic on the ground that the candidate was, by his calling, disqualified for obtaining a medical degree. Despite which the University proceeded to examine Ould and granted him the degree of M. B. on January 27, 1761. This incident inaugurated a controversy between the University and the College that continued for many years. Ould had studied in Paris under Grégoire, and located in the practice of midwifery in Dublin in 1738.

A

TREATISE

OF

MIDWIFRY.

IN

THREE PARTS.

BY

FIELDING OULD, Man-Midwife.

DUBLIN:

Printed by and for OLI. NELSON at *Milton*'s Head in *Skinner-Row*;

And for CHARLES CONNOR at *Pope*'s Head at *Essex-Gate*, M DCC XLII.

Fig. 12.—Facsimile of the title page of *A Treatise of Midwifry* by Fielding Ould, Dublin, 1742.

His *A Treatise of Midwifery* (Fig. 12) (in three parts) was published in Dublin in 1742 and was the first work on midwifery to be published in Ireland. A number of interesting observations appeared in Ould's treatise, among which we may mention:

> "The Manner of assisting a weak Patient in her last Lábour-Pains, by introducing a Finger into the Anus, has never before been taken Notice of by any Author which I have seen; which I wonder at, for the good Effects of it, are obvious to the meanest Capacity."

There is also a very outspoken criticism of Deventer who, as may be recalled,

Ould was elected Master of the Dublin Lying-in Hospital[1] in 1759, succeeding Bartholomew Mosse, the first master. Ould was knighted in 1759. A. H. McClintock says:[2]

"From certain facts with which I have been made acquainted by some of Ould's immediate descendents, I entertain no doubt whatever that he it was who attended the Countess of Mornington at the births of the Marquis of Wellesely, and of the still more illustrious, Arthur, Duke of Wellington."

Fielding Ould's treatise on midwifery marked definite progress in British midwifery and was a worthy forerunner of the many notable contributions of the Dublin School.

William Smellie.—Probably no single individual contributed so much to the development of midwifery as did Smellie, and all students of midwifery

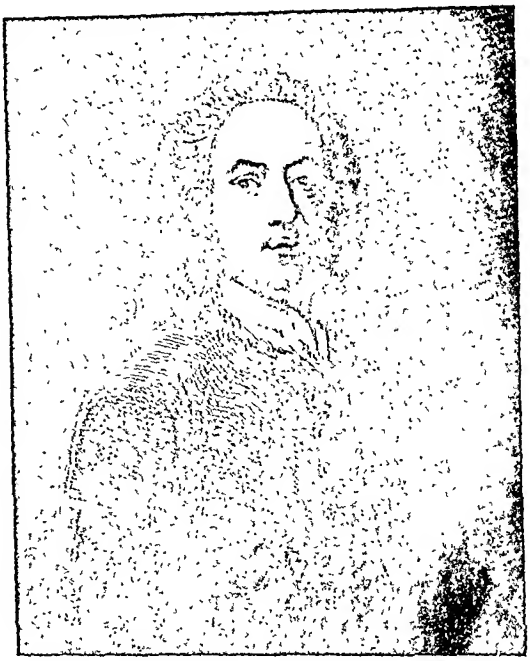


Fig. 13.—William Smellie. Frontispiece of the Sydenham Society edition of Smellie's works.

of the period cannot but be impressed with his sincerity and frankness, his sound judgment and his desire to teach.[3] William Smellie (1698–1763) (Fig. 13) was born at Lanark and was educated in the public schools of his native town. He probably studied medicine as an apprentice to some Glasgow surgeon.[4] At any rate Smellie began the practice of medicine on his own account in Lanark in the year 1720. His interest in midwifery must have been

[1] Founded by Dr. Bartholomew Mosse in 1745; a new building was erected and occupied December 8, 1757.

[2] *Annals of Midwifery in Ireland.* John Ringland, Dublin, 1870, p. 18.

[3] *Dr. William Smellie and his Contemporaries.* By John Glaister. Glasgow, 1894.

[4] Glaister (loc. cit.) inclines to the belief that the preceptor may have been John Gordon, a practitioner of Glasgow of considerable reputation.

tion of Smellie's three volumes: the first volume, *A Treatise on the Theory and Practice of Midwifery*, was published in 1751; volume two entitled *A Collection of Cases and Observations in Midwifery* appeared in 1754, and volume three entitled *A Collection of Preternatural Cases and Observations in Midwifery* in 1764. In the advertisement prefixed to the third volume of Smellie's works, published in 1779, occurs this statement:

"The manuscript was transmitted to the person who prepared the two former volumes for the press, and even delivered to the printer, when the Doctor died advanced in years, at his own house near *Lanark* in *North Britain*."

The concluding paragraph of this advertisement is Smollett's tribute to Smellie's work:

"On the whole, *Smellie's* Midwifery stands in no need of invidious comparison, which the author has ever carefully avoided; nor does it depend for success, upon cabal, or misrepresentation; arts which have been shamefully practised against it, to the confusion and disgrace of its enemies: but the great demand for the two volumes already published, and the high esteem in which it is held by foreigners, who have translated them into different languages, are such proofs of extraordinary merit, as all the efforts of envy will not be able to overthrow."

Glaister[1] quotes a letter from Tobias Smollett under date of March 1, 1754, in which he says:

"I have nothing ready for the press but Doctor Smellie's second volume, containing cases in midwifery, and my translation of 'Don Quixote,' which will be published next year."

Smellie's activities as a teacher and practitioner of midwifery are set forth in the preface to his first volume in which he says:

". . . . I have given upwards of two hundred and eighty courses (of lectures and demonstrations) of Midwifery, for the instruction of more than nine hundred pupils, exclusive of female students: and in that series of courses, one thousand one hundred and fifty poor women have been delivered in the presence of those who attended me; and supported during their lying-in, by the stated collections of my pupils: . . ."

Smellie's plan for delivering the after-coming head was practically identical with that of Giffard. After describing the position of the hands as in Giffard's maneuver, Smellie adds this hint:

"Then stand up and in pulling raise the body so as to bring out the head in a half turn as above directed."

One of the university-trained writers on midwifery, and a vitriolic critic of Smellie, was John Burton (1710–1771) of York, who published his essay on midwifery[2] in 1751. In his preface, he says that Mauriceau is the first author worth reading—inasmuch as he gives both theory and practice and his own experiences. He expresses his admiration for Deventer, for La Motte, and finally for Giffard, and notes that practically all of the other books and pamphlets on midwifery had been written from no other motive than to let the world know that the authors existed. Burton's book reflects his egotism

[1] Loc. cit.
[2] *An Essay towards a complete New System of Midwifry.*

"The seventeenth Author, collected, as you tell us, by *Spachius*, is *Lithopedus Senonensis*, which instead of being an Author, is only the Drawing of a petrefied Child, when taken from its Mother, after she was opened; and this is evident from the Title, *Lithopaedii Senonensis Icon*, which, with the Explanation, is contained in one single Page only. The Account of it, as published by *Albosius* in 1582, in Octavo, may be seen at the End of *Cordaeus's* Works in *Spachius*, whence again, I think, it is evident you must have taken your Extracts from some bad Copier."[1]

The following indictments of Smellie are noted in the table of contents of Burton's "letter":

"Proved that Smellie (or the Person he copies from) has never read the Authors quoted, never understood them, or wilfully misrepresented their Meaning.

"Proved that Smellie has not rectified certain Mistakes in Deventer, but has mistook that Author's Meaning.

"Proved that Smellie contradicts himself, and proves Deventer's Opinion to be right.

"La Motte and other Authors vindicated against the Aspersions of Smellie and the Review Writer.

"A Catalogue of several Authors omitted by Smellie.

"Smellie's Account of the Situation of the Fœtus in Utero, and his Hypothesis of its Manner of turning therein, and his Method of feeling the Child's Head in some Stages of Pregnancy, while the Os Uteri is closed, shewn to be fallacious.

"The Weakness of Smellie's Objection to the Fœtus in Utero receiving its Nourishment by Absorption set forth, and proved to be no Argument against it.

"Bleeding, with Design to quicken Labour Pains, shewn to be wrong.

"Leaving the Placenta in the Uterus after the Birth of the Child, proved to be bad.

"Smellie's Rules when to turn the Child in the Womb, when the Forceps are to be used, when the Pelvis is too narrow and the Child's Head is too large, &c. shewn to be very obscure, in some Cases insufficient, in many Places contradictory, and in others of very bad Consequence.

"Ould's Practice in some Cases preferable to Smellie's."

He appends to his criticism of Smellie's treatise an answer to "one Kirkpatric" who in the *Monthly Review* for September, 1751, had had the temerity to criticise Burton's treatise on midwifery. The occasion of Burton's attack upon Smellie was actuated probably by the unusually favorable notice of Smellie's work that appeared in the same journal.

John Burton was born at Colchester June 19, 1710. At the age of eighteen, he was matriculated at St. John's College, Cambridge. His medical studies were pursued in Leyden under Boerhaave and Albinus, in Paris under Gré-

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interesting as one of the earliest special works, and as being the largest old collective work. Spachius presents no original views of his own, but contents himself with collating the works of his predecessors; he has in this way preserved for us many writings which to-day are exceedingly rare in the original editions. The work is not in any sense a curio or rarity, nor is it interesting for its strange views and superstitions; it actually contains much of value, much in common with the teaching of to-day; it is therefore of great importance to the historical student.

"I find very properly at the beginning, the anatomy of the female genitals by Felix Plater, a distinguished pupil of Vesalius, a fact readily recognized from the anatomical plates. Plater's description of the female testes and the vas deferens of the female recalls the long prevailing ancient view of conception as being the result of the fusion of the menstrual with the seminal fluid, the ovaries were therefore called the female 'testes,' from which the fluid was conducted by the '*vas deferens*' (Fallopian tube) to the uterus.

"The works of Cleopatra, Trotula, Rueff, Paré and Guillemeau, and Baunin's Latin edition of Rousset's Cæsarean section are all here, together with a long critique of the works of Hippocrates. The Lithopædion Senonence is figured."

[1] This error was corrected in Smellie's second edition.

"Don't think, because Midwifery has been hitherto chiefly in the Hands of Women, that it is a trifling Affair; very far from it, be assured, as every Operator can testify. If at first setting out you meet with some easy Cases, don't think they will be all so, if you do, you will be greatly mistaken; don't depend upon Chance or Fortune, for they are both blind, and will deceive you. The Operation is often one of the most difficult in all Surgery, and the Art depends upon as nice a Foundation as any, and some Cases you will find will make you sweat plentifully in the coldest Day in Winter; and if any of these difficult Cases should occur, before you are well versed in the Operation, for the sake of your own Reputation, as well as the Life of the poor Woman and Child, I hope, and believe you will gladly desire the Assistance of some skilful man in the Profession. . . .

"Remember never to be ill-natured or use harsh Expressions to the poor Woman in her Pains, though sometimes you may have great Provocations. Let nothing ever make you in a Hurry, or force Nature before she is ready. Never on any Account discover any thing relating to the Fair-Sex in Company, or suffer any Discourse concerning it, to be set on Foot, as has been too often very foolishly done by some of the Profession."

Pugh states that his book was ready for publication some four years earlier and that he attempted to publish by subscription, but the subscription did not fill. Had his publication date been 1750 instead of 1754, he would be entitled to priority on a number of important points.

His description of podalic version is remarkably clear. He emphasizes the fact that the toes of the child shall be downward; that if they do not remain so the operator shall keep

". . . turning the Child as you draw forwards, so that the Belly may be toward the Mother's Back by the Time you have drawn it as far as the Breast. . . . when you have got it thus far, pull it down pretty tight from Side to Side which will lower the Arms into the *Vagina*."

Pugh then describes the delivery of the arms which must be performed "gently" and extracted with care:

". . . you must then introduce the Fingers of your Left-hand into the *Vagina*, under the Child's Breast, and put the first and second Fingers into the Child's Mouth pretty far, so far however, that you are able to press down the Child's Tongue in such a Manner that by keeping your Hand hollow, and pressing it upon the Mother's *Rectum*, the Air may have Access to the *Larinx*, you will soon perceive the *Thorax* expand, as the Air gets into the Lungs. Many Authors make very little Trouble in extracting the Head, but without a well-formed *Pelvis*, every Operator must know there is Difficulty, and great Danger of losing the Child by its Stay in the Passage; but by this Method of giving the Child Air, I have saved great Numbers of Children's Lives, which otherwise must have died."

Here follows an interesting comment on the resuscitation of the child immediately upon delivery.

"If the Child does not breathe immediately upon Delivery, which sometimes it will not, especially it has taken Air in the Womb; wipe its Mouth, and press your Mouth to the Child's, at the same time pinching the Nose with your Thumb and Finger, to prevent the Air escaping; inflate the Lungs, rubbing it before the Fire: by which Method I have saved many."

In case of anticipated difficulty in delivery of the after-coming head, Pugh notes that he earlier devised a "curve flattish Pipe, as likewise a flexible one"[1] which

[1] This procedure is credited by Fasbender also to Joh. Peter Weidmann (1751–1819) who in 1818 published a description of his "vectis aerophorus."

until about August, 1741, when he removed to the home of James Douglas[1] in Red Lion Square. During this period of instruction in midwifery under Smellie, Hunter attended the lectures of Frank Nicholls in anatomy and Desaguliers on natural philosophy. Through Douglas's influence he was soon entered at St. George's hospital as a surgical pupil under James Wilkie, one of the founders and senior surgeon of St. George's.

Fig. 15.—William Hunter. (From the author's collection.)

His natural flare for anatomy, which had manifested itself even before he left Cullen, culminated under the inspiration of Douglas in a great desire to found an anatomical school where he could pursue his researches and at the same time instruct students and thus advance anatomical investigation. The first advertisement of his lectures appeared in the *London Evening Post* of September 16, 1746:

"On Monday, the 13th of October, at 5 in the evening will begin a course of anatomical lectures to which will be added the operations of surgery with the application of bandages, by William Hunter, Surgeon. Gentlemen may have the opportunity of learning the Art of Dissecting during the whole winter season in the same manner as at Paris. Proposals to be seen at Mr. Millar's Bookseller opposite to the end of Katharine St. in the Strand."

It appears that beginning in 1746 William Hunter delivered at least one course of anatomical lectures each year and in October, 1752, in addition to announcing his anatomical lectures, he advertised that:

". . . . subscriptions for his *Anatomy of the Pregnant Uterus* are taken in at Mr. Millar's, bookseller in the Strand and *at the author's in the Little Piazza, Covent Garden,*

[1] James Douglas (1675–1742), M. D. Rheims; F. R. S. 1706; discovered the fold of the peritoneum known as "Douglas' pouch"; anatomist of note; bibliophile; physician.

made certain proposals to the government, but these were not accepted. Undaunted, he purchased in 1766 a house in Great Windmill street and inaugurated a remodelling program. In 1768 the house was ready for occupancy and in June of that year, he was joined by his brother John and by William Hewson (1739–1774). While this anatomical school was not destined to survive as a permanent establishment, it may fairly be said that it inaugurated a new era of anatomical study and investigation in England and its influence was world wide.

In 1774 Hunter's *The Anatomy of the Gravid Uterus* (Fig. 16) appeared—the work of thirty years. It contained thirty-four plates, the earliest dating from 1750, most of them drawings by Andrew Van Rymsdyk (d. 1780), although two were engraved by Sir Robert Strange (1721–1792). This book represents one of the most remarkable productions of the eighteenth century.

Aside from his *The Anatomy of the Gravid Uterus*, William Hunter contributed little to obstetrics. Certainly he did not influence clinical obstetrics to any great extent, although his practice was chiefly confined to that field. He interspersed his lectures on anatomy with lectures on midwifery, although it is said that his midwifery lectures were chiefly anatomical.

It is unfortunate for the historian of clinical midwifery that he did not leave accurate notes of his cases. Samuel Foart Simmons[1] in his life of William Hunter writes that Dr. Hunter, while interested in the anatomy, physiology, and pathology of parturition was not deeply interested in clinical midwifery. Through a series of fortunate circumstances, William Hunter succeeded to the midwifery practice of Sir Richard Manningham and Dr. Sandys. He was not compelled to go through the arduous process of building a practice and establishing himself and a careful study of contemporary data leads one to believe that he was far from being a master of clinical midwifery. He was a pronounced conservative and decried any form of interference no matter how desperate the situation. This attitude on the part of Dr. Hunter no doubt served to repress operative interference on the part of bold but ignorant practitioners. As Dr. Hunter well knew, the more ignorant the operator, the more willing was he to employ his instrumental armamentarium. Nevertheless the policy of leaving all to nature was in many cases unfortunate, and prejudice against the use of forceps, no matter how skilfully applied, retarded in definite measure the progress of midwifery.

The unfortunate disagreement which caused the separation of the lives and ambitions of the brothers Hunter occurred in 1754. Inasmuch as the basis of the quarrel had to do with maternal and fetal anatomy, it may well be mentioned here. It appears that Colin Mackenzie (d. 1775), one of William Smellie's assistants, had made in Smellie's dissecting room an unusually careful injection of the veins and arteries of a cadaver of a pregnant woman. On exposing the uterus the appearance of the placenta and placental site appeared to Mackenzie to be unusual and John Hunter records that he was asked by Mackenzie to examine the specimen. John Hunter writes:[2]

"After having dissected the uterus with the placenta and membranes, and made the whole into preparations, etc., I returned home in the evening and communicated what I had discovered to my brother, Dr. Hunter, who at first greeted it and me with good-humoured raillery; but on going with me to Dr. Mackenzie's he was soon convinced of the fact.

[1] *Account of the life and writings of William Hunter.* London, 1783.
[2] *On the structure of the placenta* communicated to the Royal Society, 1780.

volume of the first edition is dated 1783; and on the title page of each volume of the second edition, following the list of booksellers, is the date, 1784. The two editions are identical as to paging and subject matter. On the reverse of the title page of the first edition another publication of the author is mentioned, *Cases of Insanity*. In the same position in the second edition there is added *An Address to the Public on the Subject of Insanity*.

William Perfect dedicated his book to Samuel Foart Simmons,[1] M. D. Most of the case reports had been sent to Perfect's former teacher, Colin Mackenzie,[2] and the latter's comments are included with the reports to which they pertain. Among his case reports the following are worthy of note: In Case XXI he cites the history of a woman who awakened in the night with a severe hemorrhage about two weeks subsequent to delivery, the bleeding continuing beyond the resources of her physician, when Perfect was summoned. He packed the vagina full of fine tow and oxycrate, kept the patient perfectly quiet in a horizontal position and gave her an opiate. The packing came away spontaneously three days thereafter and Perfect says "the patient has since got through two pregnancies without any similar complaint." Perfect quotes Hoffman as advising packing the uterus with pledgets of lint dipped in a solution of the colcothar of vitriol, and says that Levret arrested a case of violent hemorrhage by introducing a piece of ice into the uterus which caused a sudden contraction of the organ. Le Roux of Dijon in a similar situation is quoted as packing the vagina with linen and fine tow moistened with vinegar.

Perfect's two volumes comprise the most carefully and accurately detailed case reports in British midwifery of the period. His thought is direct, the diction precise, and the meaning clear. His references to contemporary and older writers evidence wide and accurate reading.

In addition to his interest in midwifery Perfect devoted much study to the subject of insanity and was the founder of the asylum for the insane in West Malling; this still exists. His poems, some of which were published, attracted more than local notice.

Mention has been made of many of the important teachers of midwifery in London in the latter half of the eighteenth century. It was impossible for medical students to secure adequate instruction in midwifery in the general hospitals of London, although, as we have noted, French hospitals, particularly the Hôtel Dieu, more than a century earlier had opened the lying-in wards to both male and female students. Many of the London teachers of midwifery had received training in France and naturally were desirous of establishing like opportunities for the English students. One of the most forceful teachers was John Leake.

John Leake (Fig. 18) (1729–1792) was born at Ainstable, Cumberland, and received his M. D. degree at Rheims in August of 1763. He was admitted as a licentiate of the College of Physicians in 1766. His death occurred August 8, 1792, and he was buried in the north cloister of Westminister Abbey.

[1] Samuel Foart Simmons (1750–1813), fellow of the Royal Society; member of the Royal College of Physicians, and President of the Medical Society of London; member of the Royal Medical Societies at Paris and Edinburgh, and of the Royal Academy of Sciences at Montpellier. "A gentleman, whose Medical Writings are distinguished by much Observation and just Reasoning; and, whose Genius and Abilities recommended him to the highest Rank in his Profession."

[2] See page 37.

"These advantages will be specified in their CERTIFICATE, implying such means of *real Improvement*, as will justly entitle the young *Accoucheur* to the confidence of his Patients when he commences *private Practice.*"

"Gentlemen desirous of being *expeditiously qualified*, may have ample and immediate opportunity of improvement by *extra Privileges* at Lectures and Hospital."

He further states that one house-surgeon will be admitted once every three or six months and will be entitled to "privileges extraordinary":

"He may attend the Lectures as a *perpetual Pupil*, and will be allowed a *double share of Labours;* being also permitted to touch every patient at the time of admission into the Hospital during his residence there, he will from thence become expert and judicious in the *Art of Touching*, and dexterous in *all Cases of danger or difficulty.*

"He will be present at all *preternatural and laborious Cases*, as Dr. Leake's assistant, and see the treatment of Diseases incident to Lying-in Women, namely, those of *Child-bed Fevers, Uterine Hæmorrhages, Convulsions, etc.*

"He will be permitted to examine the *morbid appearances* of bodies opened at the Hospital, with a view to illustrate the Cure of Diseases imperfectly understood; and to take *Clinical Minutes* of all such *extraordinary cases.*"

Dr. Leake's winter course of lectures began the first day of October and a new course the first Monday of each succeeding month during the winter season. Evidently his plans included the training of midwives as he says female pupils may be instructed and duly qualified for practice by being allowed to reside in the hospital. Dr. Leake introduces the description of his obstetrical apparatus with the statement that midwifery cannot be taught by lectures alone:

". . . nothing but Practice itself can adapt the Student's hand to the easy and judicious Performance of manual Operations: Therefore, for the clearer illustration of this Art, the several difficult Labours will be artificially represented on Machines of new Construction, substituted for the real bodies of Women and Children. In the first, all the parts concerned in PARTURITION are fabricated upon the Female Skeleton, in exact imitation of Nature; and in the last, the effect of Pressure on the Infant's head, will be exemplified by an artificial Fœtus.

"By *means of this* Apparatus, each difficult case will be reduced to Demonstration, *which will afford the Pupil such* solid Practical Knowledge *as cannot be forgot. From thence he will become acquainted with the Position most conducive to speedy Delivery; and acquire* Skill and Dexterity *in applying the* Forceps, *and other Instruments used in* Laborious Cases; *but particularly, in* preternatural Labours, *where the Patient's life depends upon his* immediate assistance, *he will learn the proper method of turning the Infant, by an* artificial Uterus, *which contracts on the hand of the Operator,* (by imperceptible means), *with any degree of force required, so as to give him precisely the same ideas of difficulty as present themselves in Nature;* and in a manner not demonstrated by any other Apparatus in Europe."

Included in the pamphlet is a brief account of the founding of the Westminster Lying-in Hospital which relates that:

"In the year 1765, Dr. *John Leake* of Craven-Street, London, purchased a piece of Ground on a Building Lease, and afterwards presented to the Public, the *Original Plan for the Institution of this Hospital.* Soon after the Building was raised, he voluntarily, and without any consideration, assigned over to the Governors, all his right of the above Ground, in favor of the said Hospital." . . .

"The Institution of this Hospital, was principally designed to relieve the *Wives of distressed Housekeepers*, who either from unavoidable misfortunes, or the expense of maintaining large families, were *reduced to real want;* also, for those of *Soldiers and Sailors*. But the Governors moved with compassion at the many severe hardships of *Single Women*, who, on that account, were rejected elsewhere; they unanimously resolved to admit such of them as are deserted and in deep distress; with the humane intention of saving them from *Despair*, and preventing the lamentable Crimes of *Suicide*, and *Child Murder!*"[1]

city. Dr. Richard Croft[1] (later Sir Richard Croft) (1762–1818), who had married one of Denman's daughters, became his associate in practice, and may be regarded as his successor in clinical midwifery.

Through his writing and teaching Thomas Denman wielded a greater influence upon English midwifery than that of any of his predecessors with the exception of Smellie. His numerous essays were republished again and again and served as guides and manuals for thousands of practitioners. Five editions of his *Introduction to the Practice of Midwifery* appeared during his lifetime and the text was in demand for many years after his death.

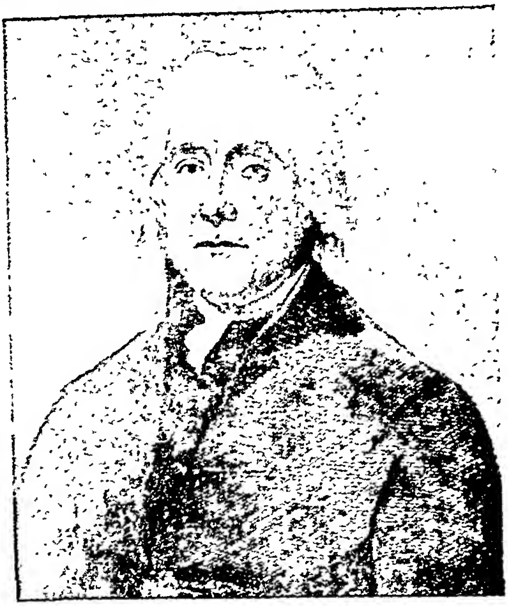

Fig. 19.—Thomas Denman. (From the author's collection.)

John W. Francis (1789–1861), an eminent teacher of midwifery in New York City, brought out an American edition in 1821. In his preface Francis remarks:

"The high practical merit of the original work is universally acknowledged."

In clinical midwifery, Denman was distinctly conservative and his contributions to the science of midwifery lie in his careful, sane procedures with a just reliance upon the forces of nature. He was the first to describe the spontaneous evolution of the fetus and his treatment of puerperal convulsions by bleeding, hot packs and opiates was, in his hands, unusually successful.

Before concluding the discussion of this period in British midwifery mention must be made of the importance of the lying-in hospitals. Not only did they provide an asylum for poor and distressed mothers, but they were of paramount importance in placing clinical teaching at the command of eager students. Spencer[2] lists the following institutions:

[1] It will be recalled that Sir Richard Croft attended Princess Charlotte at the suggestion of Mathew Baillie (1761–1823), although it is reported that the Princess desired a midwife. The death of Princess Charlotte, as a result of her confinement, so depressed Croft that he committed suicide February 13, 1818.

[2] Loc. cit.

ings of the Board on Tuesday and Saturday of each week; (4) three members of the governors shall constitute a quorum for the transaction of business at every weekly board meeting; (5) none but married women, or widows of newly deceased husbands may be admitted to lying-in at this hospital; (6) all drugs, medicines, materials and necessaries shall be bought from persons who will furnish them at a reasonable rate and preference shall be given to tradesmen who are subscribers.

Certain prominent practitioners and teachers of midwifery of this period are mentioned in the chapter devoted to Puerperal Fever.

THE CHAMBERLENS AND THE DEVELOPMENT OF THE FORCEPS

No single factor has contributed quite so much to the advancement of the science of midwifery as the invention of the obstetrical forceps. This instrument provided a means of saving the lives of many mothers and infants. While the literature of midwifery contains hints here and there of instruments somewhat resembling the forceps of the Chamberlens, it is evident that no clear conception of the "two-blade" forceps existed prior to the time of early members of this interesting family. Jacob Rueff (1500–1558), of Zurich, described a pair of forceps without teeth.[1] Dr. Heinrich Fasbender[2] (1843–1914) believes that Rueff had a clear idea of the use of the forceps for the delivery of the living child and that he had devised his instruments by omitting the teeth from earlier models used for the purpose of delivering the dead fetus. Rueff, it will be recalled, possessed a correct knowledge of the anatomy of the female pelvis and advised manual delivery of the placenta.

While numerous other authors hinted at "forceps-like" instruments, the weight of evidence points to the invention of the short straight forceps by some member of the Chamberlen family,[3] probably the one known as Peter the Elder, who was born in Paris about 1560 and whose death occurred at

[1] *De Conceptu et Generatione Hominis, et iis quae circa haec potissimum considerantur, Jacobi Rueff, Chirurgi Tigurini*, 1554. Later German editions were published under the title *Hebammenbuch, daraus man alle Heimlichkeit dess weiblichen Geschlechts erlehrnen*, etc., in Zurich in 1559; at Frankfurt in 1580, 1588 and 1600; Latin editions under a somewhat altered title were published at Frankfurt in 1580 and 1587.

[2] Heinrich Fasbender studied medicine at Bonn, Würzburg and Berlin, receiving his M. D. in 1865. He was assistant in the department of obstetrics at the Universitäts-Klinik in Berlin 1867–1869; began lecturing on obstetrics and gynecology in the University of Berlin in 1871. His *Geschichte der Geburtshülfe* was published at Jena in 1906.

[3] The several members of the Chamberlen family are apt to be confused. To make the sequence perfectly clear, a family line has been adapted from Aveling. This diagram does not show all the descendants of William Chamberlen; only those known to be concerned with the midwifery forceps.

William Chamberlen = Genevieve Vingnon

Peter the Elder (I) (1560–1631)

Peter the Younger (II) = Sara de Laune (1572–1626)

(Dr.) Peter (III) = Jane Myddelton (1601–1683)

Hugh Senior = Dorothy Brett (b. 1630)

Hugh Junior (1664–1728)

Paul (1635–1717)

John (d. about 1700)

"That a Freeman of London may be lawfully imprisoned by the College."

Evidently Peter Chamberlen was a "test" defendant upholding the cause of the barber surgeons against the College of Physicians, for it is recorded that the barber surgeons had frequently complained of their limitation in not being empowered to prescribe medicines for their patients. Aveling notes that Peter Chamberlen the Elder did not submit passively to his imprisonment and as a result the Lord Mayor interceded for him, and a demand was made by the judges of the kingdom that Chamberlen be discharged, but this demand the College denied inasmuch as he had been committed for "malpraxis." Finally the Archbishop of Canterbury,[1] at the request of the Queen,[2] prevailed upon the censors and Peter was released. Some measure of Peter Chamberlen's influence and fame may be inferred from this incident.

The following year, Peter the Younger, no doubt resenting the attitude of the College toward his elder brother, expressed his opinion of that institution in no uncertain terms, for the minutes of the College for November, 1613, record that:[3]

"Dr. Fludd[4] complained that Peter the younger had used most insolent language against himself and others, members of the College."

In 1616 both Chamberlens joined in a petition for the incorporation of the Society of Midwives. The petition of the midwives was addressed to Sir Francis Bacon[5] (1561–1626), a member of his Majesty's most honorable Privy Council, as well as to the King, and was referred to the College of Physicians for consideration. In the denial of the College occurs this paragraph:[6]

"Nevertheless they think yt neither necessary nor convenient that they should be made a Corporacon to govern within themselves a thinge not exampled in any Commonwealth."

Aveling notes that Peter the Younger married Sara de Laune,[7] and of this union the elder son, born in London May 8, 1601, became known as Dr. Peter Chamberlen (Fig. 21). He first attended Emmanuel College,

[1] George Abbot, Archbishop of Canterbury, 1610–1633.

[2] Anne of Denmark (1574–1619) married James I (1566–1625) (formerly James VI of Scotland) in Norway in 1589.

[3] Aveling, loc. cit.

[4] Robert Fludd (1574–1637), M. D. Oxford, 1605; practiced in London and was four times censor of the College of Physicians. He became involved in a controversy with Kepler and Gassendi; and published works in defense of the rosicrucians, some of them under the pseudonyms, Rudolf Otreb and Joachim Frizius.

[5] Sir Francis Bacon, one of the most important of the early English philosophers, had been elected to the position of Lord Chancellor, only to fall under the charge of bribery and to be condemned to indefinite imprisonment in the Tower. To the advantage of English learning a commutation of his sentence permitted him to spend the remaining years of his life in productive writing, the value of which becomes more apparent with the passing years.

[6] Aveling, loc. cit.

[7] Sara de Laune was the daughter of William de Laune, a licentiate of the College of Physicians, and a sister of Gideon de Laune, a wealthy apothecary.

"'Mrs. Hester Shawe[1] and Mrs. Whipp, Midwives presented a peticon to the College it being readd it appeared meerlye to concerne Dr. Chamberlayne, concerning the making of Midwifes a Corporacon and himselfe to be gouernour of it. Dr. Chamberlayne desyred to have the Copye of the peticon but it was denyed him till he should give into the Colledge: his propositions made to the Kinge: or that he should submite his cause to the Censors which hee refused.'

"A committee, consisting of Dr. Argent[2] the President, Drs. Clement,[3] Foxe,[4] Fludd, Baskerville,[5] Winston,[6] Hodson,[7] Meverall,[8] Ridgley,[9] Spicer,[10] and Hawley,[11] was appointed and met on September 8th, 1634, to consider the midwives' petition, and draw up an answer to be presented to the Lords appointed to hear their cause:—"

The petition of the midwives recited that their business had been interfered with by Dr. Peter Chamberlen: that he had been appointing them to meet at his house once every month without authority; that they believed he intended to appropriate unto himself the sole power of licensing them; and that he assumed that he had more skill in midwifery than "all the grave and learned Physicians in the Kingdom." This petition was forwarded to the Lords with an accompanying pronouncement of the College of Physicians to the effect that the College believed the complaints of the midwives to be "grounded on just grievance," adding that Dr. Chamberlen is

". . . not otherwise able to instruct them than any other the meanest Fellow of our College unless he understand it by the use of *iron instruments* which Physicians and Chirurgions may practise if they please and some do and have done with as good success and dexterity as himself and therefore there is no necessity of a sole dependence upon him.

[1] Mrs. Hester Shawe is probably the Mrs. Shawe of whom Willughby writes: "There was a scandalous report in London with which an old midwife was spotted; that through a mistake, instead of the after-birth shee pulled away the womb, of which the woman died. But I will not bee so injurious to old midwives as to give credence to such unworthy reports." Willughby's leniency toward the reported mistakes of midwives may have been due to the fact that a relative practiced as a midwife: "a good kinswoman of mine (Mrs. Willughby, that was a long experimented midwife, of much practice, and of good repute with women, dwelling in Westminster and London."

[2] John Argent (d. 1643) received his M. D. degree from Cambridge, 1597; was admitted a fellow of the College of Physicians in 1598 and served as president of the College from 1625 to 1633.

[3] William Clement (1569–1636) received his M. D. from Padua; was admitted a licentiate of the College of Physicians in 1605 and a fellow in 1607; he served as censor for several years and registrar of the College 1629–1636.

[4] Simeon Foxe (1568–1642) received his M. D. from Padua. He was president of the College of Physicians from 1634 to 1640.

[5] Sir Simon Baskerville (1574–1641) studied at Oxford, receiving his M. D. in 1615, and in the same year was admitted a fellow of the College of Physicians. He was physician to James I and Charles I (1600–1649). Knighted in 1636.

[6] Thomas Winston (1575–1655) received his M. D. from Padua and on his return to England in 1608 he was incorporated at Cambridge. He was admitted a fellow of the College of Physicians in 1614; professor of physic in Gresham College 1615–1642.

[7] Eleazer Hodson (d. 1638) received his M. D. from Padua in 1612 and was incorporated at Oxford in 1615. He was admitted a fellow of the Royal College of Physicians in 1618.

[8] Othowell Meverall (d. 1648) received his M. D. from Leyden in 1613, was admitted a fellow of the College of Physicians in 1618 and served as president from 1641 to 1644.

[9] Thomas Ridgley (d. 1656) received his M. D. from Cambridge in 1608 and became a fellow of the College of Physicians in 1622.

[10] Richard Spicer (d. 1640) studied at Oxford and received his M. D. in 1622. In 1623 he was admitted a fellow of the College of Physicians.

[11] Richard Hawley (1593–1636) received his M. D. from Leyden in 1627 and became a fellow of the College of Physicians in 1630.

"Bloud (which polutes a land, and cries aloud to heaven) runs yet fresh from the innocent veins of Women and Children, for want of some Charitable Samaritanes to bind up the wounds which Ignorance and Disorder amongst some uncontroled femal-Arbiters of Life and Death, and others daily make."

A contemporary writer, Percivall Willughby, who did much to advance English midwifery, paints a dismal picture of the origin and qualifications of the midwives of the period:[1]

"I could heartily wish yt some publick good order might be made for ye better educating of all, especially ye younger midwives, for ye helping and saving of mothers and their children. When ye meanest of ye women, not knowing how otherwise to live, for the getting of a shilling or two to sustain their necessities, become ignorant midwives, their travailing women suffer tortures."

Mentally restless Chamberlen soon turned to the making of bath stoves and was granted a monopoly for this purpose by the Lords and for many years devoted his efforts to the subject of baths and wrote among other treatises, *A Vindication of Publick Artificiall Baths and Bath Stoves* (London, 1648).

Because of his failure to attend the meetings of the College of Physicians, he was dismissed from his fellowship on November 23, 1649. For some time before his death he turned his attention to religious, political, and economic themes, most of them so fanciful that they fell of their own weight. At one time he was compelled to defend himself against the charge of insanity. Before his death Dr. Peter Chamberlen was appointed physician-in-ordinary to Charles II (1630–1685). Woodham, Mortimer Hall, which he had purchased of Sir Cranmer Harris, continued in his family till about 1715, when it was sold by his son, Hope Chamberlen, to Mr. William Alexander, wine merchant, who bequeathed it to the Wine Coopers' Company. Dr. Chamberlen died on December 22, 1683, at Woodham, where his obstetrical forceps and other instruments were discovered in a secret receptacle under the floor of a closet in June, 1813. These instruments were later (1818) presented to the Medico-Chirurgical Society of London. From the contents of the receptacle it seems perfectly clear that these were the actual instruments used by the members of the Chamberlen family. The discovery of the forceps of the Chamberlens is thus related by H. H. Carwardine:[2]

"Two or three years ago, a lady with whom I am intimately acquainted (and from whom I had the particulars) discovered in the floor of the upper closet a hinge, and tracing the line she saw another, which led to the obvious conclusion of a door; this door she soon found means to open. There was a considerable space between the floor and the ceiling below, and this vacancy contained divers empty boxes, etc. Among these was a curious chest or cabinet, in which was deposited a collection of old coins, trinkets, gloves, fans, spectacles, etc., with many letters from Dr. Chamberlen to different members of his family, and also the obstetric instruments. Being on terms of intimacy with the family resident at Woodham Mortimer Hall, these instruments have been presented to me, and I have now the gratification of depositing them with your society for the gratification of public curiosity, and to secure to Chamberlen the meed of posthumous fame due to him for his most useful discovery."

[1] *English Midwives; their History and Prospects.* By J. H. Aveling, London, 1872.
[2] *Observations on the Discovery of the Original Obstetric Instruments of the Chamberlens.* By Robert Lee. *Medico-Chirurgical Transactions*, 2nd series, vol. xxvii, London, 1862.

his practice in spite of the fact that he failed to make public the secret of his forceps.

The family tradition of "war" with the College of Physicians was carried on by Hugh Chamberlen, as on one occasion he was summoned before the College, found guilty of prescribing an improper remedy and fined ten pounds. He was appointed physician-in-ordinary to Charles II, and was elected a member of the Royal Society.

In 1685 he published his *Manuale medicum; or a small treatise of the art of physick in general*, etc., and in 1694 he published in London another manual, *A few queries relating to the practice of physick, with remarks upon some of them*, etc. In this latter work, as Spencer[1] points out, he proposed a health insurance plan for the entire population of England, in which all persons were to be attended by physicians and surgeons of known and approved skill and all necessary medicines were to be furnished. Three conditions only were noted in which the patient was to pay an additional fee, namely, the pox, midwifery and cutting for stone. Every person was to pay something and the annual fee was to be a graded sum, based upon the patient's income and wealth. In the light of English panel practice and state medicine in many European countries, this plan strikes a modern note. In 1702, Hugh Chamberlen published a scheme for the union of Scotland and England under the title, *The Great Advantages to Both Kingdoms of Scotland and England, by an Union—By a Friend to Britain.* As Aveling notes, this is the only one of the Utopian dreams proposed by the Chamberlens that was destined to be realized.

The later years of Hugh Chamberlen's life were spent in Holland, where he resided until his death. He made the acquaintance of von Roonhuyse to whom he is said to have sold a model of his lever.[2] Aveling seems to believe that von Roonhuyse possessed the complete forceps. Dutch writers in referring to von Roonhuyse, however, mention the lever, or single blade. Before his death Chamberlen took out a Swedish patent on his forceps and later a Danish patent.[3]

Dr. Chamberlain's Midwifes practice: or, a guide for women in that high concern of conception, breeding, and nursing children[4] (Fig. 22) was probably written by **Dr. Paul Chamberlen.** The preface is addressed "To the English ladies and gentlewomen, especially to the more Studious in the ensuing Subject," and is signed "Your real Friend, P. C." The author states that he has designed the volume

". . . having observed the want of a Treatise of this Nature, seeing there is nothing of it compleat, but deficient, ignorant and imperfect; and that a great many Women

[1] Loc. cit.

[2] Von Roonhuyse's lever according to Herbineaux (*Traité sur divers accouchemens Laborieux, et sur les Polypes de la matrice*, etc., Brussels, 1782) had a curious history and was an instrument of great utility in the hands of a limited number of Dutch obstetricians. From Von Roonhuyse and his son the lever passed to Ruysch, then to Jean de Bruyn, who records over eight hundred successful cases managed by means of the lever. Von der Heyden secured the instrument from de Bruyn and in turn passed it on to Jacques de Vischier and Hugo Vandopoll. How much barter and sale and how much of the scientific spirit actuated these heirs to the lever it would be difficult to trace. By the time it reached the last named, the forceps were becoming known. An article dealing with the lever by Vischier and Vandopoll is included in the French edition of Smellie's midwifery.

[3] *Les Chamberlen.* By Scharffenberg. *Ann. de Gynéc. et Obstét.*, 1888, vol. xxix.

[4] London, 1665.

The volume consists of 288 pages of text, nearly two thirds of which comprises such a plethora of prescriptions that one might well imagine the author to be master of the Society of the Apothecaries. Nicholas Culpeper is occasionally referred to as "quacking Culpepper," or "carping Culpepper," and "the Rules he (Culpeper) so much vapours with," are ridiculed. Only slight attention is given to the mechanism of labor; nothing is said about dystocia, and no plan of delivery outlined, neither is there the suggestion (as occurs in Hugh Chamberlen's translation of Mauriceau) that the midwife, when in difficulty, send for the assistance of a surgeon or someone skilled in the art.

The imprint:

> "London, Printed for Thomas Rooks at the Lamb and Ink-Bottle, at the East-end of S. Pauls; who makes and sells the best Ink for Records. 1665"

is probably characteristic of the bookseller or publisher who takes advantage of a bit of space at the end of a short glossary to advertise in well-nigh modern phraseology three proprietary preparations, two of which are secrets of "P. C.," the author.

> "An excellent powder, to procure easie delivery in Childe-bearing women, being a secret of the Authors is there sold with directions.
> "Sovereign Tabulats to cause conception, and prevent miscarriage, and other accidents in women: cures the green sickness, fits of the Mother, and Convulsion fits, with directions to use them; all sold at the same place."

It would appear that if this treatise was written by one of the Chamberlens, the authorship should be ascribed to Paul (1635–1717), the second son of Dr. Peter Chamberlen or to Dr. Peter himself. In 1665 Paul was thirty years of age, Hugh was thirty-five, whereas Dr. Peter was aged sixty-four. The two advertised remedies may have been but "trial flights" in the development of the "Anodyne Necklace" said to have been the invention of Paul and "recommended to the World by Dr. Chamberlen for teething Children, women in labor, etc." Aveling[1] notes that after the death of Paul Chamberlen all sorts of quack medicines were sold "up one pair of Stairs at the Sign of the Anodyne Necklace next to the Rose Tavern without Temple Bar."[2]

Hugh Chamberlen, Junior, the eldest son of Hugh Senior, was born in London in 1664 and died June 17, 1728. He was educated at Trinity College, Cambridge, where he graduated M. D. in 1689. As a member of the College of Physicians, he associated apparently on friendly terms with many of the eminent physicians of the day, particularly Dr. Richard Mead.[3] His mental processes appear to have been more stable than were those of his father or grandfather; perhaps he was less an individualist. At any rate the family

[1] Loc. cit.

[2] A careful bibliographical study should be made of the writings of the Chamberlens. Much confusion exists in published bibliographies and Aveling apparently left the task for some later student of the subject.

[3] Richard Mead (1673–1754) received his M. D. degree from Padua in 1695, and began the practice of medicine the following year at Stepney. He became a fellow of the Royal Society in 1703; was physician to St. Thomas's Hospital, 1703–1715; fellow of the College of Physicians in 1716 and censor in 1716, 1719, and 1724; anatomy lecturer to the barber surgeons, 1711–1715; attended Sir Isaac Newton (1642–1727), George I (1660–1727) and George II (1683–1760).

The fact that a pair of obstetrical forceps was found among Drinkwater's instruments indicates that forceps were probably much more common than published data would indicate. In this connection we must recall Chapman's statement,[1] published in 1733:

". . . . the use of the forceps, now well-known to all the principal men of the profession, both of the town and country."

Johnson says of Drinkwater's forceps that they resemble those of Chapman and Giffard in size and form "save only that the hooks of the handles are turned outwards," and that they impressed him as clumsy and ill-adapted. He says it is almost impossible to conceive

". . . . how they could be used without injury, even in the hands of such expert operators as Chapman and Giffard: for they are straight, and measure ten inches in the claws, five and a half in the handles, which make fifteen and a half in the whole length: the rings, towards the points, are roundish, and measure two-eighths of an inch thick; and as to their weights, though a little different, taking the medium, each of them weighs twenty ounces Troy."

Renouard[2] believes that Jean Palfyn[3] (1650–1730) (Fig. 23) should be known historically as the inventor of the forceps. Palfyn no doubt had heard of the instruments employed by the Chamberlens, and may even have seen them used. At any rate, although an anatomist and professing no special interest in midwifery, he devised an instrument which he called the *tire-tête*, consisting of two steel spoons (Fig. 24). While in Paris in 1720, supervising a French edition of his work on anatomy,[4] he exhibited his forceps at a meeting of the Académie Royale de Sciences. In 1723 the instruments received the approbation of the Medical Faculty of Paris. No published description of the construction of the forceps or their use appeared from the pen of Palfyn. In fact no reference to the forceps can be found in Palfyn's writ-

[1] *A Treatise on the Improvement of Midwifery, chiefly with regard to the Operation.* First ed., London, 1733.

[2] *History of Medicine, from its origin to the nineteenth Century.* By P. V. Renouard. Translated by Cornelius G. Comegys. Cincinnati, 1856.

[3] Jean Palfyn was born in Courtrai, Belgium, November 28, 1650, the son of a barber-surgeon. He began the study of anatomy under his father and early evinced an insatiable desire to perfect himself in this subject. Largely through his own efforts he acquired a thorough knowledge of Latin. Later he was apprenticed to a surgeon in Ghent for three years. In 1674 he went to Paris and became a pupil of Jean Devaux and Pierre Dionis. After several years of study in Paris he returned to his native city of Courtrai, where he remained until 1686, when he journeyed to Ypres. Subsequent to his residence in Paris he used Leeuwenhoek's microscope and was fully abreast of the advances in anatomical science. In 1695 he is known to have been practising surgery in Ghent, where he published in Flemish his first book entitled *Nieuw Osteologie*, [illegible] 1701. In 1703 he published a monograph on the anatomy of joined twins and in 1710 appeared his work on surgery. In 1721 he presented to the Royal Academy of Sciences of Paris an instrument with which he could as with artificial hands help the delivery of the head. Levret, writing in 1747, says: "It is about twenty-five years ago that Palfyn, a surgeon at Ghent and Demonstrator of Anatomy in that city, came to Paris to publish his anatomy. He presented at this time to the Academy of Sciences an instrument to draw by the head infants locked in passage. He received the commendation as being the inventor of it. But Gilles Le Doux, surgeon at the city of Ypres, objects, saying that he invented it." (See article on Jan Palfyn by John Bethune Stein, *Medical Record*, N. Y., 1913, vol. lxxxiii, p. 47.)

[4] First edition published in Leyden in 1710.

ings.[1] His friend, Lorenz Heister[2] (1683–1758), however, illustrated Palfyn's forceps in the 1724 edition of his *A general system of surgery*[3] (Fig. 25). Heister showed little enthusiasm for Palfyn's device as he notes in the 1743 edition of his surgery that he had attempted to use Palfyn's forceps and was unable to demonstrate their utility.[4]

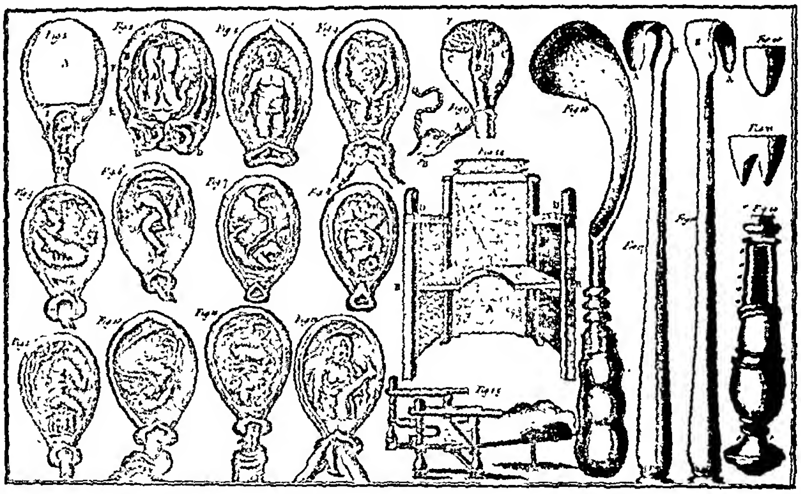

Fig. 25.—Engraved plate, from *A General System of Surgery* by Lorenz Heister, London, 1768, showing one blade of Palfyn's forceps (Fig. 16) and positions of the fetus *in utero*, the birth chair, etc.

It is evident that the Chamberlen family could not defeat the inventive genius of practicing obstetricians and a better understanding of the mechanism of labor resulted in the independent invention of the midwifery forceps.

[1] Attention must be called to the fact that all of Palfyn's works had appeared prior to 1721, with the exception of the French edition of his surgery which appeared in Paris in 1726.

[2] Lorenz Heister studied at Giessen, Leyden and Amsterdam. After serving as surgeon in the Dutch army he was called to Altdorf in 1710 and to Helmstadt in 1720. He devoted himself to anatomy and surgery, and his books made him an indisputable authority on these subjects.

[3] The first edition was published at Nuremberg in 1718.

[4] Lorenz Heister, in his *Institutiones Chirurgicae*, Amsterdam, 1739, says: "The modern physicians and surgeons who were the most skillful in the art of obstetrics have given themselves much trouble to invent an instrument by the aid of which they can save the mother and infant. *Palfyn is the first*, so far as I can learn, who has invented for this end, as I have already stated in article X, a sort of hook with the end large and obtuse, which I have had first engraved in my XXXII Plate, Fig. 16. This author has succeeded in delivering infants whose heads had been fixed and were immobile in the passage without hurting or tearing. But experience has taught me that success with their instruments is difficult and sometimes absolutely impossible, especially when the head is forcibly locked and the instrument has not sufficient grip, so that each of the blades leaves the head when one attempts to pull. I have appreciated for a long time that the instrument of Palfyn needs to be corrected and brought to greater perfection, and with this in view I suggested in my 'Instructions in Surgery' that the two branches be united by means of a mobile axis or be bound strongly together so that they will press upon and hold the head more firmly and be less liable to slip. I see that my idea has been adopted by many obstetricians who, by joining the two blades on an axis or bond have given the instrument the form of a forceps or pincers by which they can extract either a child alive or dead, with an impacted head." See article on Jan Palfyn by John Bethune Stein, loc. cit.

"Grégoire demonstrated to us, amongst other instruments, two large long spoons which could be coupled by means of a transverse cross-hook. This instrument he called the *tire-tête* of Palfyn, and taught us that it was of use in extracting living children by the head without injury. It seemed to me very serviceable and worthy of adoption, therefore I was surprised to witness M. Grégoire extracting children with the crotchet, and sacrificing the living child on more than one occasion, instead of employing this instrument which could save the child. . . . I noticed that the *tire-tête*, which he had demonstrated to us, was very rusty, from which I concluded that Grégoire himself did not make use of this instrument, though he had recommended it to us, doubtless because of his own experience of it had been unfavourable.

"Later on, I lived in the house of M. Dusée, another well-known obstetrician, who showed me and my fellow-traveller, Mr. J. Boswell, now a Doctor of Medicine in Edinburgh, another instrument for the same purpose, which he declared to us was his own invention. It was the forceps a sample of which was obtained from him by Mr. Alexander Butter and represented in the third volume of *Medical Essays* of Edinburgh, I never saw him use it, for unfortunately soon after we took up our abode with him he fell ill and died. We saw him, however, deliver a few women. We bought the instrument from his heirs and it fell to the lot of Mr. Boswell, but I had another constructed immediately, and after returning to Zealand in the Netherlands I soon found by experience that it was unsuited for its purpose. It was far too large and I could not introduce it into the body of my patient."

Alexander Butter, a surgeon of Edinburgh, read his essay, *The Description of a Forceps for extracting Children by the Head when lodged low in the Pelvis of the Mother*, before the Medical Society of Edinburgh in 1733. The article was not published until 1735 when it appeared in Volume III of the *Medical Essays and Observations* accompanied by an engraving of the forceps (Fig. 26). At the reading of his paper Butter exhibited a pair of forceps

". . . . which I had from Mr. Dusée who practises Midwifery at Paris and who believes it to be his own Invention."

In describing the method of use, Butter states that the blades

". . . . are to be separated and each introduced along the side of the vagina and betwixt it and the Side of the Child's Head as far as immediately above the Ears, then the two Blades of the Instrument being crossed, the *Axis* is put into the Hinge, which the Operator finds most convenient to employ, after which the Child's head is to be taken firm hold of, and the Operator pulling by the Handles, extracts the Child."

Butter concludes his essay:

"You will easily see, that often when the Head of a Child is a little too far foreward on the *Ossa Pubis*, or turned too far backwards, that one Blade only of this *Forceps* can be employed to bring it to a right Situation, and to assist the Birth."

William Giffard.—A full year prior to the publication of Alexander Butter's article, there appeared Edward Hody's collection of William Giffard's cases in midwifery, published in London in 1734. The first plate in this volume figures a pair of obstetrical forceps which Hody labels "Mr. Giffard's extractor" (Fig. 27). Another section of the same plate is entitled "The Extractor as improved by Mr. Freke, Surgeon to St. Bartholomew's Hospital." Johnson[1] says in discussing the second portion of this plate that Freke had made an "alteration. . . . I cannot say an improvement." It will be noted, however, that Freke flattened the blades of Giffard's forceps and curved the ends of the handles outward. According to his case reports Giffard first used the obstetrical forceps on April 20, 1726.

[1] Loc. cit.

the Improvement of Midwifery, Chiefly with regard to the Operation, etc., in which he illustrates his forceps (Fig. 28) and gives a sufficiently detailed description as to permit the construction of the instruments by a competent iron-smith.[1] He says:

"I have now subjoin'd an exact Draught of my *Forceps*, which is very little different from that used by the late Mr. *William Giffard;* and which I apprehend too of a Make preferable to those represented in the *Medical Essays*, etc. (Dusée's forceps) as taking better Hold of the Child's Head. . . ."

Chapman remarks that men who practice midwifery should make themselves masters of either the forceps or the fillet:

". . . . the *Forceps* gives me a much stronger Hold of the Child, and enables me to draw it with more Ease and Security."

The following paragraph would further indicate that certain types of forceps were reasonably well known to practitioners of midwifery for several years prior to 1735:

"But here I must observe, that as there are several different Sorts of Forceps, so they are far from being all equally proper; and great regard is to be had to their Form. I once saw a Pair at a noted Instrument-Maker's, which I thought very faulty; and was shewn a Pair by a Brother Practitioner in the Country, which could not be used with either Success or Advantage; the Diameter of the Curve being too large, and its Bows too short."

Of his own forceps, Chapman says:

"I can, from my own Experience, affirm it to be a most excellent Instrument, and so far from Hurting or Destroying, that it frequently saves the Mother's Life, and that of the Child, as will appear in the Course of this *Treatise*.

"As to the Forceps, which, I think, no Person has yet any more than barely mentioned, it is a noble Instrument, to which many now living owe their Lives, as I can assert from my own Knowledge and long successful Practice."

Chapman gives explicit directions for the introduction of the forceps. He says the handles of the forceps are then to be brought close together and

". . . . if you please, the Screw may be put through and fastened with the *Button*, tho' there is no occasion for the Loss of so much Time; for without doing this, the *Hand* will prove sufficient to keep them together; and thus you may extract the Head, by drawing gently down.

"It is much better, as I have just observed, that the two Parts of the *Forceps* should not be joined or fixed by a *Screw*, the Hand being sufficient, and that for these Reasons. *First*, because when they are screw'd together, tho' they should not happen to be exactly opposite to each other, yet they will turn so as to take fast Hold of the Infant's Head, and readily extract it. *Secondly*, In case one of the Parts should slip, it is then easily returned to its proper Post, without being taken wholly away: Whereas when they are screwed together, and then slip off on one Side (which I have often experienced, in spite of the greatest Care I could use) the Instrument is to be repassed, and screwed as at first. They have

[1] "The Dimensions of the Forceps, as inserted in this Edition, after Page 22 are as follows:

"'Their Length in a Right Line, Fifteen Inches. The Length of the Bows from the Joint, where the two Parts cross, to the Upper Extremity, in a Right Line, Nine Inches and one Quarter. The Girt of the Bows, when shut, is, in the widest Part, Eight Inches.'

"N. B. Fig. I. Represents one Part of the Forceps, Fig. II. the Whole, not quite shut."

Fig. 29.—André Levret. From *Accoucheurs et sages-femmes célèbres* by G. J. Witkowski.

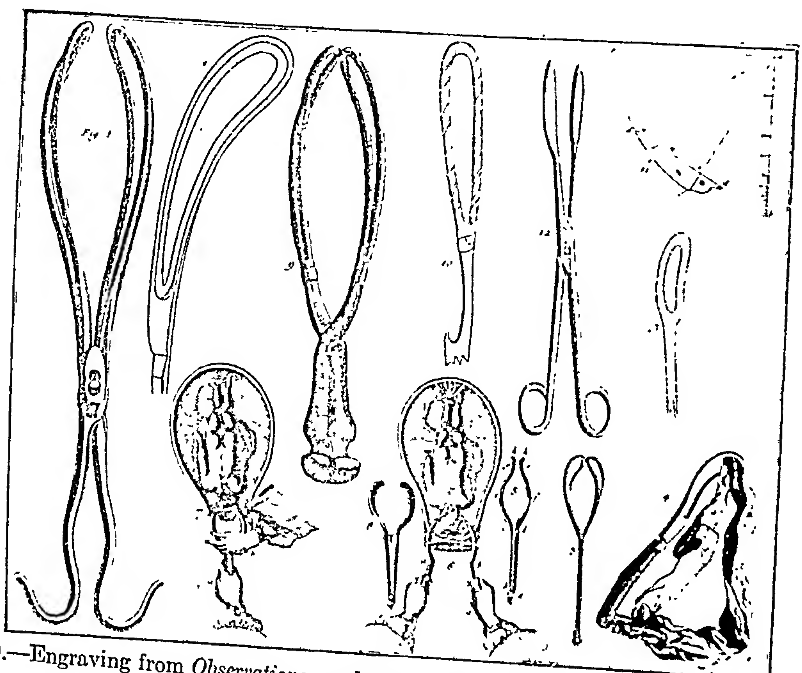

Fig. 30.—Engraving from *Observations sur les Causes et les Accidens de Plusieurs Accouchemens laborieux* by André Levret, Paris, 1762.

"I shall be as particular as possible, in the Description and Use of all the Instruments both in Midwifery and Surgery (which are my own Invention). Their good Effects I have experienced many Years, and by the Help of these in Midwifery, I have succeeded in De-

The following description by Pugh might well be taken from a modern text and is the first published detailed description of a forceps delivery:

"The Forceps must be introduced one Blade after another . . . first introducing the Fingers of each Hand to carefully guard the Bows past the *Os Uteri*, and fairly over the Side of the Head; for should the *Os Uteri* get between the Head and Forceps, it would at once prevent any firm Hold of the Head, and consequently fail you in the Attempt, and also bruise the Part that intervenes, so as to endanger an Excoriation and great Inflammation. When both Blades are introduced, and the Head properly between the Forceps, they are to be brought close together, and the Nitches fixed into each other; taking Care, if the Nitches are within the *Vagina*, that none of the *Rugæ* get between . . . when the Pains come on, begin to pull the Head along from Side to Side, till you find it advance to the external Parts; then pull slowly, gradually dilating the Parts, which ought to have been lubricated well with Pomatum, raise the Handles of the Forceps, and pull the Head upwards, that it may turn out according to the Shape of the Curve Forceps, and prevent a Laceration of the *Perineum*. When I have brought the Head through the Bones of the *Pelvis*, so that I find it free and quite at the external Parts, I generally then unhitch the Forceps, and withdraw first one Blade, and then the other, . . ."

It was the illustration of Dusée's forceps in the article by Alexander Butter that intrigued **William Smellie**, and resulted in the development of Smellie's forceps. Smellie had a pair of forceps constructed on the model of Dusée's instrument according to the plate that accompanied Alexander Butter's essay. As Smellie says:

". . . but (I) found them so long, and so ill-contrived that they by no means answered the purpose for which they were intended."

He immediately simplified the design of the forceps and developed his short straight forceps made of iron, the blades covered with leather. Smellie's forceps proved most satisfactory and held the field for many years in spite of the numerous modified designs that followed. Smellie recognized the advantages of the pelvic curve of the forceps, as is set forth in the preface of his second volume (1754):

"In my first, among the improvements and alterations that have been made in the forceps, I mentioned a long pair, curved to one side, which I contrived several years ago, for taking a firmer hold of the head in the *Pelvis* when high; but, I did not then recommend the use of them, because I was afraid of encouraging young practitioners to exert too great force, and give their assistance too soon. Of late, however, I have found them very serviceable in helping along the child's head, in preternatural cases, after the body and arms of the *Fœtus* were brought down, and it could not be delivered without destroying the child, by overstraining the neck and jaw.

"On such occasions, they are more convenient than the shorter and straight sort, because they take a firmer hold, as will appear in the perusal of Tab. XXXV."

Table XXXV in Smellie's treatise shows a lateral view of the pelvis, and the method of assisting the delivery of the after-coming head of the fetus with the long curved forceps.

Describing Smellie's forceps, Johnson says:[1]

"Dr. Smellie (to whose mechanical plan the art of midwifery will ever stand indebted) made several improvements on this subject. He altered the Chamberlen's (?) forceps to a better form, as may be seen by his plates; the length of the clams he reduced to six inches and a half; and that of the handles to five; in all, making eleven and a half: the weight was reduced to twelve ounces Troy; and to avoid disagreeable uneasiness or hurt to the patient, he covered them with leather."

[1] Loc. cit.

and depended either on a modification of the Dusée forceps or upon an early model of Smellie's instrument. The forceps known to be Burton's are now in the library of the York Medical Society, York, England.

The advantages of the pelvic curve were promptly recognized, and Robert Johnson,[1] a pupil of Smellie, includes in his treatise, a plate showing forceps with a pelvic curve.[2]

While improvements in traction devices were made by many obstetricians, among whom should be mentioned Hubert of Louvain, and James Hobson Aveling, it remained for Etienne Stéphane Tarnier (1828–1897), French ob-

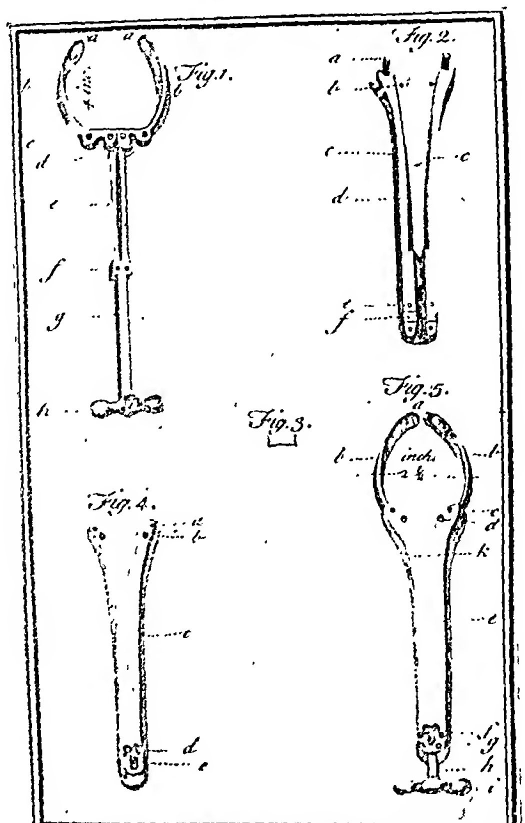

Fig. 32.—Burton's forceps. From engraved plate accompanying *An Essay towards a Complete New System of Midwifry* by John Burton, London, 1751.

stetrician and teacher of eminence, to devise a type of traction that exactly coincided with the resultant of the pelvic lines of force. Tarnier's memoir was published in 1877. His forceps were modified by A. R. Simpson and have since been modified by others.

In 1915 Christian Kielland of Christiana, Norway, introduced a new type of forceps. The pelvic curve is practically discarded and in the hands of certain operators the instrument has proved to be unusually successful where the head is high and where the instrument proves of utility as a rotator.

[1] Loc. cit.
[2] Plate VI, fig. 1.

during the Middle Ages and Paré was the first writer to describe clearly the delivery of the child by bringing down the feet. Later this method was popularized and greatly advanced through the work of his favorite pupil, Guillemeau.

Jacques Guillemeau (1550–1612) was born at Orleans. He was unusually well educated for his time, having been one of the brightest pupils of Jean Riolan (1538–1606), and a favorite of Paré, whose works he translated into Latin.[1] After serving with the Spanish army in Flanders he became surgeon

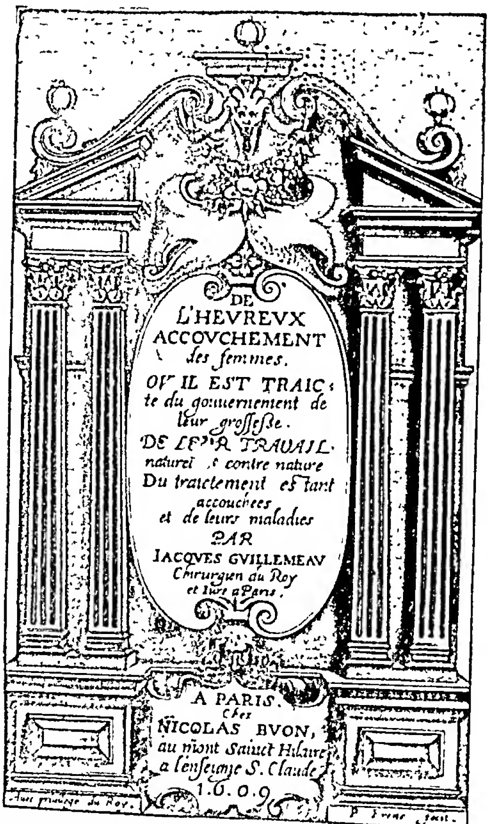
DE
L'HEVREVX
ACCOVCHEMENT
des femmes.
OV IL EST TRAIC-
té du gouuernement de
leur grossesse.
DE LEVR TRAVAIL
naturel & contre nature
Du traictement estant
accouchees
et de leurs maladies
PAR
IACQVES GVILLEMEAV
Chirurgien du Roy
et Iuré a Paris.
A PARIS.
Chez
NICOLAS BVON,
au mont Sainct Hilaire
a l'enseigne S. Claude
1.6.0.9

Fig. 33.—Facsimile of the title page of *De l'Heureux Accouchement des femmes* by Jacques Guillemeau, Paris, 1609. (Crerar Library.)

to the Hôtel Dieu in Paris. During his life-time he served as surgeon to three of the kings of France—Charles IX, Henry III, and Henry IV. Among Guillemeau's works may be mentioned a history of French surgery,[2] an important book on midwifery of 1049 pages,[3] and a work on surgery.[4] For the purpose

[1] *Opera Ambrosii Parei regis primarii et Parisiensis chirurgi.* Paris, 1582.

[2] *La chirurgie françoise, recueillie des antiens médecins et chirurgiens, avec plusieurs figures des instrumens nécessères pour l'opération manuelle.* Paris, 1594.

[3] *De la grossesse et accouchement des femmes.* Paris, 1620.

[4] *Les oeuvres de chirurgie, avec les portraicts et figures de toutes les parties du corps humain, et des instruments nécessaires au chirurgien, augmentées et mises en un et enrichies de plusieurs tractez, pris des leçons de Germain Courtin.* Paris, 1612.

was to deliver her promptly. This was done and she was delivered of a living child after which the flow of blood ceased."[1]

Three case histories are recorded of like circumstances in which the life of the mother was saved. Guillemeau cites three additional cases in which the parents of the woman in labor would not give their consent to manual delivery, and because of lack of assistance the patients died.

Section 2, Chapter 18, is entitled "On Delivering the Mother when the Child Presents One or Two Feet First." In this chapter Guillemeau notes that when a child presents one or two feet first, the surgeon must consider carefully what he is to do. He has two choices, either to draw the child out by the feet, or to thrust the feet back into the uterus to effect a cephalic version. Guillemeau prefers to deliver the child by the feet, believing it easier and safer. When the child presents one or two feet, it is very necessary to know the position of the body in the uterus:

". . . to know if the face and abdomen of the child are turned toward the back of the mother. It is a curious thing that in all abnormal labors, when the feet present first, the arms of the child are extended over the head."

Guillemeau continues:

"It is absolutely necessary to determine, when the legs and thighs of the child have been delivered, whether the shoulders and face of the child are turned down or are turned up, facing the umbilicus of the mother. For if one delivers the child to the neck, and then finds the head face up, it will be very difficult to deliver it without catching the chin on the pubic bone. If this occurs, the neck is very likely to be broken, particularly if the infant has a large head. If this is the case, the whole position must be changed. It is better and safer to determine just what the position of chest and face is before the infant is delivered any farther than the waist. Then, if the child is in the wrong position, it is easy to grasp its thighs and turn the whole body gently so that the chest and face are down. Then the infant can be drawn out without catching its chin on the pubic bone. . . .

"One must be very careful in finding the other leg. Slip the greased hand along the leg and thigh clear up to the perineum and determine carefully where the other leg is joined. For it is possible when there are twins, as happens often, to grasp a leg of each child, therefore, of course, killing both the infants and the mother by attempting to deliver them thus.

"The doctor must be very careful to have a warm piece of linen with which to draw the child out, for his hands are covered with oil and it is otherwise impossible to hold it firmly."

Allport[2] says that Guillemeau achieved the greatest distinction of Paré's many pupils; that if Paré revived podalic version, Guillemeau and his colleague, Honore, devised our present method of bringing down the feet in cases of hemorrhage from placenta praevia. Cumston, on the other hand, says[3] that Guillemeau was a poor successor of Paré; that his writings are so incumbered with useless material as to render them of little value.

Guillemeau wrote not only on surgery and midwifery but on ophthalmology as well, and his book, *Traité des Maladies de l'Oeil, qui sont en Nombre de Cent Treize, ausquelles il est Suject* (Paris, 1585), on account of the excellence

[1] Although Guillemeau does not definitely state that he performed the delivery it is probable that he did so.

[2] *An Old Midwife's Tale.* By Walter H. Allport. *Chicago Medical Recorder*, vol. xxxiv, 1912.

[3] *Paul Portal, His Life and Treatise on Obstetrics.* *Am. Jour. Obst.*, vol. li, 1905.

is treated by "drying up the humours." Leucorrhea is mentioned and prescribed for, as is also the elongated cervix.

The actual management of delivery described in her book follows the teachings of Paré and Guillemeau. For example, in a transverse position, she suggests bringing down the feet. The same procedure is recommended in a shoulder presentation and when the arm presents she says it must be replaced instantly, the best way being to allow the infant's hand to rest in a pan of cold water "whereupon it will put it back very soon." Evidently, this did not always eventuate for she says:

> "If, however, the child is too feeble to do this, grease the arm before it has time to swell, replace it gently, and then turn by the feet."

According to Jean Astruc,[1] Loysa Bourgeois' writings contributed much to the advancement of French midwifery. As a rule she objected to bleeding; she reasoned that the depletion of the circulation incident to parturition was sufficient for all purposes. Astruc gives her credit for advocating prompt delivery in premature separation of the placenta.

The following, which appears in Chapter V of her text, while advising prompt delivery does not indicate that she performed the delivery herself:[2]

> "When a woman has an immoderate flooding in her pregnancy, in consequence of which she grows very weak, recourse must be had to the extraction of the child by the hand. I had it performed, by consent, and in the presence of the late M. le Febvre, a physician, and Messrs. le Moine and de L'isle, very learned physicians also; because I had seen, that these floodings are soon the cause of the death both of the mother and the child. This was done in the case of the wife of a counsellor of the court of parliament, who was in the sixth month of her pregnancy: the child lived two days, and the mother has had several children since. The physicians acknowledged, that if it had been deferred one hour longer, the mother and the child would both have been dead."

The method of delivery necessitated by "immoderate flooding" is described in her manual. The description begins with the manual dilatation of the cervix by first introducing the forefinger, then the thumb, followed by the other fingers. As soon as the entire hand is able to enter the cavity of the uterus the membranes are ruptured and the feet are brought down. Manual delivery of the placenta is advised should there be signs that it has not become completely detached.

In Chapter XVIII, Madame Bourgeois outlines[3] the procedure which was later recommended by the English obstetrician, Chapman, and which is found in many compilations of old authors.[4]

> "As soon as the woman is delivered, after a hard labor she must be put in the skin of a black sheep which has been flayed alive. This is applied to the back. To the belly is applied the skin of a hare which has also been flayed alive. The animal having been flayed, its throat should be cut and the warm blood should be rubbed on the inside of the skin and applied to the body of the woman. This blood chases away the melancholic blood. In winter these remedies must be kept on two hours and in summer one hour."

[1] *The Art of Midwifery reduced to Principles:* etc. London, 1767.
[2] Quoted from Astruc. Loc. cit.
[3] Quoted by Hunter Robb in *Remarks on the writings of Louyse Bourgeois, Johns Hopkins University Bulletin*, 1893, vol. iv, p. 75.
[4] *The Practice of Physick.* By Lazarus Riverius, London, 1678, p. 525.

women, because of being so obstinate, have been the cause of things going wrong either with themselves or with their children. The queen's sickness lasted $22\frac{1}{4}$ hours, and her courage was an admirable thing. She discerned clearly the first pains as well as those last ones when the terrible colic came."

For a period of twenty-seven years, Loysa Bourgeois served the court and royal family of France until 1627, when, subsequent to the confinement of one of the royal princesses,[1] the patient developed sepsis and died. At the postmortem performed by "ten learned physicians," the typical findings of peritonitis were found. The autopsy report relates that:

"The matrix was, so to say, floating in a pus-like substance, which filled the lowest part of the abdomen from the umbilicus to the symphysis pubes. The matrix was infected by cancer[2] from the outside into the wall, especially on the left side and at the place where it touches the rectum. Within the matrix on the right inner side and at the bottom or wider part, a small piece of the placenta was found, attached so firmly that we could hardly take it off or separate it with our fingers."

Loysa Bourgeois answered the implied criticism of the autopsy findings in an "Apologia," dated Paris, June 8, 1627, in which she says:

"The cause of the Duchess's death was an inflammation of parts of the abdomen, where, according to their own verdict, pus had collected, against which the uterus could not battle. This infection in such quantity could result from nothing else but from inflamed tissues and bowels, which finally developed cancer and caused the watery substance of the blood to retreat to the cavity of the abdomen, gradually changing into pus. Doctor Riolanus in presence of the king, of the dowager queen, and of the Lord Cardinal,[3] announced the cause of her death (which could not be prevented) as nothing else but cancer in the lower parts of the abdomen. This part was swollen, as firm as a drum, and as if she had not been delivered of her child."

And here we have a few lines of biography set forth in an effort to bolster her defense:

"I have practiced my profession now for fully thirty-four years, faithfully, diligently, and honorably, and acquired not only a good certificate, after various examinations, but have also written books treating on this subject, which have been printed and published in several editions and were translated into foreign languages, for which trouble many noted physicians have rendered me thanks and have gladly confessed that they were of great use to humanity. If I had knowingly left a piece of the placenta inside the matrix, I should have mentioned it in time, in order to have asked advice and help. And should I not have known it easily enough by simply examining the placenta? Such a mistake would have been evident, within twenty-four hours, by symptoms which never fail to develop in that time. As none of the conditions referable to retained placenta appeared, and the lochia showed neither bad color nor odor, you men of science who are such experts in the diseases of the child-bearing woman should have warned us to prepare for other dangers."

Despite her "Apologia," the protocol signed by the "learned doctors" placed the stamp of disapproval upon her work and her services to royalty were discontinued. The remainder of her life—she was now sixty-four years of age—was spent in writing her memoirs and recollections, which some commentators add "might better have been left unrecollected."

Guillemeau, as we have noted, made many important improvements in technic and Madame Bourgeois served as an elevating influence among

[1] The Duchess d'Orleans (aet. 20) was before her marriage Mademoiselle d'Montpensier, daughter of the Duchess d'Montpensier.

[2] Allport (loc. cit.) says "ruptured pus tubes."

[3] The "Lord Cardinal" was Cardinal Richelieu.

This translation placed the important advances made by Mauriceau at the immediate command of the English-speaking world.[1] In his preface to the reader, Mauriceau says:

"The *Doctrine* of Books, which is one of the most wholsom effectual Remedies we have to chase away *Ignorance*, is wholly useless to Mens Wits, when not disposed to receive it."

He then suggests the reading of other "learned" authors but with this caution, that

". . . the most part of them, having never practised the Art they undertake to teach, resemble (in my Opinion) those *Geographers*, who give us the description of many Countries which they never saw."

In the translator's preface, Chamberlen says that, recognizing the need of clear and explicit directions for the government of women with child and in child-bed, he had "designed a small manual to that purpose," but having come across Mauriceau's book on a journey to France[2] and regarding it as unusually valuable, he determined to translate it "for the benefit of our midwives."

"The principal thing worthy of their observation in this Book, is, accurately to discover what is properly their Work, and, when it is necessary to send for advice and assistance, that so, many Women and Children may be preserved, that now perish for want of seasonable help."

Chamberlen's preface states that he has inserted marginal notes to indicate wherein his opinion differs from that of the author (Mauriceau). These marginal notes are in italics and, although not numerous, afford an interesting sidelight on Chamberlen's practice.

Because of the epoch-making character of Mauriceau's book, a few excerpts may be of interest. Of manual dilatation of the cervix he says:

"After I had thus prepared my self for it, that is, having directed two of my Fingers into the inner Orifice of the Womb, being open enough to admit them into it, I did in a little while after introduce a third, and by degrees the ends of all the five of my right Hand, with which I dilated the Orifice sufficiently to admit it quite in, as it is very easy in the like case, because the abundance of Blood moistens and relaxeth extreamly (as is already mentioned) the whole Womb, into which having so gently entred my Hand, I found the Child came right, and the Waters not yet broken; wherefore I presently broke the Membranes with my Nails and Fingers, and then turning the Child, I took it by the Feet, and brought it forth very easily, after the manner I shall teach in the forementioned 14th Chapter of the 2d Book, all which I finished in less time than a hundred could be counted, and do conscientiously protest never to have delivered a Woman sooner in all my Life, of those whose Children came against Nature, nor easier, and with less violence to the Mother."

Mauriceau corrects the common conception that the uterus contains two cavities and the tradition that the woman could give birth to but two children because of the presence of two breasts.

". . . this is very true of other Animals, but the Womb of a Woman hath but one only cavity."

[1] See mention of Mauriceau in connection with Hugh Chamberlen in the section on forceps.
[2] Hugh Chamberlen spent many months in Paris in the year 1670.

Mauriceau cites the case of a certain obstetrician who often slept near the woman in labor, and who, because he was so accustomed to the sounds from the labor room,

". . . never awaked till just the Child was in the Passage, and which time the Woman changeth her Moans into loud Cries, which she strongly repeats, because of the greater and more frequent Pains which she then feels."

The expectant mother is admonished, if she would shorten her period of labor and assist the child to come right, to walk about the chamber for by this means the weight of the child assists in the dilatation of the cervix. Furthermore her pains will be stronger and more frequent. If the midwife perceives that the child is not presenting properly, Mauriceau cautions her to

". . . send speedily for an expert and dextrous Chirurgeon in the practice, and not delay, as too many of them very often do, till it be reduced to extremity."

And he reassures the midwives they need not fear

". . . that the Chirurgeons should take away their practice, or to appear ignorant before them, that they chuse rather to put all to adventure, than to send for them in necessity: others are so presumptuous, as to believe themselves as capable as the Chirurgeons to undertake all. . . ."

"There are some who do maliciously put such a terror and apprehension of the Chirurgeons in the poor Woman, comparing them to Butchers and Hangmen, that they chuse rather to die in Travail with the Child in their Womb, than to put themselves into their hands: . . ."

To which Chamberlen (the translator) adds—"a necessary note,"—"avoiding such midwives if women value their lives."

There is a pertinent caution against pulling on the umbilical cord in order to deliver the placenta:

". . . lest by breaking the string near the Burthen, as sometimes happens, you be obliged to put up the whole hand into the Womb, to deliver the Woman; or that the Womb, to which this Burthen is sometimes strongly fastned, be not drawn forth with it, as hath been done to some that I knew: . . ."

Finally there is a splendid paragraph on the duty of the surgeon both to the patient and to the family:

". . . if there be any hope, though never so little, either for Mother or Child, we are obliged in Conscience to do what Art commands, and not as some Politicians, who will rather suffer a poor Woman to die without assistance, than undertake a doubtful Operation. Wherefore 'tis better to attempt an Operation of an incertain consequence, than to abandon the Sick to certain Despair; for sometimes Nature recovers beyond hope; but before the Chirurgion undertakes it, let him give his Prognostick of the great danger of Death, both Woman and Child is in, which he must acquaint the Husband and Friends with, and the Woman herself, if he thinks that she is able to bear it, that so she may receive the Sacrament before the Operation, . . ."

Among Chamberlen's numerous annotations, particularly in the chapters dealing with the actual delivery of the child, are pertinent comments. Relative to the chapter on dismembering the fetus in order to secure delivery, Chamberlen says:

who were called upon to assist the midwives in difficult labors in the wards. The lying-in pavilion of the Hôtel Dieu in Portal's time is described as a semi-basement room having windows on one side and so damp from the periodic overflow of the Seine that in 1660 other quarters were found in the old lithotomy room, called St. Joseph's Ward. There the obstetrical service was carried on for nearly one hundred years. Contemporary accounts relate that this ward was dangerously overcrowded; that in 1660 there were four or five women in the same bed. In 1780 the ward contained sixty-seven large and thirty-nine small beds, accommodating 193 women. Under these conditions Portal worked, protested and finally resigned. Naturally, puer-

Fig. 37.—Paul Portal. Frontispiece of thesis entitled *Paul Portal: sa vie; son oeuvre* by Emile Maruitte, Paris, 1900.

peral fever was rife and epidemics succeeded one another with great rapidity —1662, 1663, 1664; each year with hundreds of victims. In the epidemic of 1746 only one woman in twenty survived. During Portal's time about one hundred women were delivered each month and the unclaimed infants were sent to the Foundling Hospital. It is recorded that of 1503 infants born at the Hôtel Dieu in the year 1678, the Foundling Hospital received 1304. In 1683 encouraged by numerous colleagues, Portal decided to publish the clinical observations that he had been collecting for many years, and in 1685 his *Pratique des Accouchements* appeared.[1]

[1] *Paul Portal, His Life and Treatise on Obstetrics.* By Charles Greene Cumston. Am. Jour. Obst., vol. li, 1905.

function, and it being a place that goes by favour, I was forced to rest contented with following, in the quality of topic (clerk), the physicians that attended there alternately for two months in the year: And thus I followed, during six months, Dr. *de Bourges*, *Oxon*, and *Morin;* during which time I observed carefully the conduct those gentlemen kept towards new laid women: Thus I made up, in some sort, for my want of recommendation; but I can protest, that during those six months, there was but one extraordinary case, wherein the presence of the surgeon was thought requisite; which was a child that stuck in the passage, and that came forth at last without any other help but that of patience; and yet in that time there were between three and four hundred women, most of whom were *delivered* by the women pupils, and few of them by Madame *de la Marche*, then head midwife of the hospital."

La Motte considers that he himself has actually made some discoveries of importance and says that in spite of the handicap of his lack of training in midwifery in the Hôtel Dieu

". . . . by joining reading to practice, observations to reading, and reflexions to observations, I soon acquired more reputation than I could have hoped for, having often performed three or four *deliveries* in a day with success, in any situation of the child, and without the help of the *crotchet*, or any other dangerous instrument."

He expresses his admiration for Julien Clément, who exemplifies his opinion that in order to become an expert obstetrician it is not necessary to have practiced in the Hôtel Dieu:

"Mr. Clément excels all the surgeons of his age in that art, and yet was never employed in that hospital."

La Motte recalls with horror the rough and inhuman practice of the unskilled and ignorant among the profession, those who used the crotchet, and dismembering instruments, resulting in death to mother and child, and says:

"I have always conformed myself to nature, which sometimes by a sudden happy change, brings to good issue a *labour* that was but just before desperate; the contrary too often happens, and a *labour* that gave the best prospect in its beginning, may prove at last a very laborious one, nothing being so variable and uncertain as *labours*."

The value of La Motte's work lies entirely in his clear description of clinical cases, which occurred in his practice covering a period of more than thirty years (1690–1720). His own comments entitled "reflexions" are appended to practically all of his 411 observations.

"I have set down my thoughts and observations in the best manner I could, having less pretence to learning than experience. I hope this confession will not make me lose the esteem of my reader, but will engage him to mind the subject itself before its regularity, or the choice of words."

In his preface to La Motte's *General Treatise of Midwifery*, Thomas Tompkyns says that he undertook the translation of the work at the suggestion of Smellie,

". . . . a gentleman, who is not satisfied with being serviceable to mankind by his own labours, but with indefatigable industry studies to enable others to be as serviceable as himself, and . . . whose excellent lectures . . . will soon cause France to cease being our rival in this branch of surgery, as it has long ceased being so in all the other branches of it."

thoroughness. In the course of his studies he made notes that developed into the lectures or lessons but he had no intention of publishing them until his attention was called to the fact that while the midwives of Paris could obtain personal instruction (as could those in other large cities that had followed the Paris plan), yet there was no opportunity for training midwives in the smaller towns or in the rural districts: in fact, there was not even a book that was readable and that would give them correct instruction. Student midwives were compelled to apprentice themselves to older women as Astruc says "by the most servile courtship," thereby learning all that they could teach them, "which was very little." Astruc had already published a book on the diseases of women and these representations, together with the fact that he did not regard the work as complete unless he subjoined a treatise on childbirth, caused him to revise his notes and his *The Art of Midwifery Reduced to Principles*, etc., was the result. This book is written in a simple straightforward style and is readily understandable by a person of average intelligence. He had the midwives of France in mind when he composed his text. At the time that Astruc was writing it had been agreed among obstetricians that in all positions, other than vertex, the child should be turned and delivered by the breech. He says:

Fig. 38—Jean Astruc. (From the author's collection.)

> "This practice is now considered as a fundamental rule in the art of midwifery; and it has contributed much towards the perfection of it, by furnishing the easy means of performing deliveries, that were formerly both very difficult and laborious, and often fatal to the child. . . . If the old prejudice, with respect to this matter, subsists anywhere yet, it is only in some corner of a province, whither truth has not been yet able to make her way."

Of premature separation of the placenta, he gives a very clear description, recognizes its dangers and wonders why through the centuries there had been no general acceptance of the plan of emptying the uterus in order to save the life of the mother.

been favorable and that the majority appeared to be opposed to it on the ground that the space secured would be inadequate, and that a reunion of the pubic bones might not occur. On the proposal the Royal Academy reported unfavorably. Undismayed Sigault again proposed the procedure in his graduation thesis at Angiers. In 1769 Antoine Louis (1723–1792), secretary of the Royal Academy, wrote to Professor Peter Camper (1722–1789) at Gröningen, describing the proposed operation, suggesting that it might have its advantages, but that it certainly was attended with great danger. Camper published in 1774 a short essay on the advantages of dividing the symphysis, calling attention to the fact that in 1759 in a Dutch translation of Mauriceau, he (Camper) had said that if some method could be devised for dividing the symphysis, it might prove of great advantage in difficult labors. Naturally Camper refers to this earlier statement and lauds Sigault for his acceptance of his (Camper's) suggestion. The opportunity to perform the operation on a pregnant woman was secured for Sigault through the cooperation of Alphonse le Roy[1] (1742–1816). This occurred on September 30, 1777, when the patient, Souchot, fell in labor with her fifth child. Prior deliveries of this patient had resulted in still-born infants. M. Sigault proposed the division of the symphysis or, if that were not acceptable, cesarean section. Both proposals were declined by numerous consultants who examined the patient. Nevertheless, Sigault and le Roy determined to proceed and the operation was performed. Each published a report of the case; that of Sigault is addressed to the Faculty of Medicine. Sigault's report states that he introduced his forefinger as a director, cut through the ligaments and cartilage of the symphysis from above downward and that immediately upon the completion of the division, the pubic bones with a peculiar noise spontaneously separated $2\frac{1}{2}$ inches, or the width of four of M. le Roy's fingers. M. Sigault then proceeded to rupture the membranes and bring down the feet of the fetus. Delivery was accomplished in five minutes and the child was born alive. The next day, every symptom was favorable, the patient passed her urine voluntarily and there was no hemorrhage. The following day at the monthly meeting of the College, both Sigault and le Roy described the operation and requested that a committee be appointed to examine the patient. This was acceded to and Messrs. Grandelas and Jean Descemet (1732–1810) were appointed. As we may well understand the patient's recovery was stormy. A vesicovaginal fistula resulted, numerous abscesses formed and it was sixty days subsequent to the operation before the patient could walk about. The committee appointed by the College reported favorably and the operation was enthusiastically approved by the Faculty of Medicine of Paris, who were lavish in their praise of the procedure. Following the report of the committee, a resolution laudatory of the genius of M. Sigault was adopted and a medal ordered struck memorializing the occasion. Naturally the affair received the widest publicity throughout France. Baudelocque[2] says that all the world knew that the Faculty of Medicine of Paris had caused a medal to be struck in honor of M. Sigault, bearing the date 1768 when Sigault conceived the idea, and the date 1777, when the operation was actually performed on a living patient, and that they obtained for him a government pension.

[1] It will be recalled that Alphonse le Roy had been branded a plagiarist and an ingrate by Baudelocque.

[2] *L'Art des Accouchemens*, vol. ii, p. 236.

of labor, his careful handling of dystocia, and his resourcefulness in meeting emergencies, placed his teaching far in advance of his predecessors. He devoted particular study to low implantations of the placenta, to placenta praevia and the management of these anomalies. Whenever possible, he recommended that the placenta be separated at the edge rather than by boldly plunging through the body. He greatly improved the procedure of podalic version and emphasized the necessity of using but light pressure in pushing the fetus upward against the fundus of the uterus.

Levret was a great inventor of instruments and is particularly remembered for his uvula scissors, for his ligature method for the removal of nasal polypi, and for his laryngeal mirror. His skill in general surgery was well-nigh equal to his skill in midwifery. His book on midwifery (Fig. 40) went through many editions and was an accepted standard guide from the close of Mauriceau's period to the beginning of that of Baudelocque.

Fig. 41.—Jean Louis Baudelocque. From A. Corlieu, *Centenaire de la Faculté de Médecine de Paris, 1794–1894*, Paris, 1896.

The work of Baudelocque carried French midwifery over into the nineteenth century and integrated the best teaching of French obstetricians with that of the rapidly developing English school led by Smellie. In the introduction to his work on midwifery, *A System of Midwifery*[1] (first edition 1781), Jean Louis Baudelocque (1746–1810) (Fig. 41) notes that he prepared his book because of the necessity of supplying an authoritative manual that would embody his teachings for the guidance of his pupils. He claims no great originality in his work, but believes that he has incorporated the best of many authors. His greatest criticism of writers on midwifery is that they lack con-

[1] Translated by John Heath, London, 1790.

relationship between this increase and toxemia, nor is it ascribable to other complications of pregnancy, such as hypertension or syphilis.[3]

The introduction of the various dyes for the visualization of the gallbladder suggested a further line of attack upon this problem. Mann and Higgins[4] concluded from their studies upon dogs, guinea-pigs and gophers that pregnancy inhibits the emptying of the gallbladder after a fat meal. Whitaker and Emerson,[5] by a parallel technic, noted no difference in pregnant cats as compared with the nonpregnant. Among 17 primiparae Levyn, Beck and Aaron[6] found 7 gallbladders which failed to visualize to intravenous dye; and of the 10 normally filling gallbladders 6 were high and showed pressure defects. Morning sickness appeared more commonly in the group failing of adequate visualization. Other workers[7] have found the dyes in early pregnancy of a value equal to that under any other condition, but question their diagnostic value late in pregnancy, due to distortion. No ill effects have been encountered from the procedure. From these observations upon the pregnant human subject stasis does not seem to be an important factor in the relationship of gestation to the incidence of gallstones.

The subsequent history of a series of patients showing hypercholesterolemia in pregnancy was followed by Ferguson and Priestley.[8] Of the 11 individuals who could be studied over one and a half years, 3 developed right upper quadrant pain, gastric distress and belching; but none had acute colic. Apparently among patients developing symptoms of cholecystitis and cholelithiasis during pregnancy, at least a third do so when the uterus is approaching the umbilicus, according to Peterson.[1] The symptoms may be very alarming if empyema of the gallbladder occurs or if a Charcot intermittent fever supervene from a "ball-valve" stone in the common duct. The latter situation appearing in the puerperium might well be confused with puerperal sepsis. Peterson gave the mortality for this complication in pregnancy as 13.04 per cent and in puerperium as 11.1 per cent.

Ferguson and Priestley[8] quite rationally advised a prophylactic regimen of reduced fats, sweetbreads, liver, kidney, oily fish, butter and cheese. If seen early in pregnancy, they advocated prompt interference, believing that surgery of choice is preferable to that of necessity. Later in the course of pregnancy delay is advised by most authorities to insure a viable child, unless the maternal situation demands immediate laparotomy.

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Intestines

Appendicitis.—The anatomical relationships of the appendix to the pelvic viscera explain the unusual gravity of its inflammation in pregnancy or during the puerperium. In an exhaustive study of the subject, Wilson[1] estimated that 2 per cent of the instances of appendicitis among women occurred in pregnancy and Schmid[2] in a review of 486 cases of this complication found that it developed more commonly in the first or second pregnancy. Eighty per cent of Wilson's cases[1] appeared in the first six months of pregnancy, while a majority of Schmid's[2] occurred from the third to the sixth month. Evidence has been advanced in support of the position that while pregnancy rarely initiates a first attack, recurrences of appendicitis are not unusual in pregnancy. The gravid uterus probably exerts no direct causal influence; but the notorious constipation of pregnancy may predispose to inflammation of this appendage.

The rapid growth of the uterus in pregnancy may lead to marked discomfort from the traction upon adhesions of an earlier appendiceal inflammation; but more important is the profound tendency for suppuration and early peritonitis in acute appendicitis complicating pregnancy. DeLee[3] drew a clear picture of the unusual hazards confronting the patient under these circumstances, among which should be mentioned inadequate omental protection, mechanical presence of the enlarged uterus, increased vascularity, thrombosis and phlebitis, higher and more dangerous site for suppuration within the abdomen, difficulties in the drainage of pus, greater interference of tympanites with respiration, greater possibility of intestinal obstruction and finally the serious chance of maternal and fetal septicemia.

Baer and his co-workers[4] recently advanced conclusive roentgenological evidence of the upward displacement of the normal appendix with advancing pregnancy. In a series of 70 pregnant women without histories of prior appendicitis, there appeared a progressive upward movement of the appendix after the third month to reach the crest of the ilium at the end of the sixth month. The long axis of the appendix underwent a counter-clockwise rotation during this upward migration to assume a vertical position in 60 per cent of cases at the end of the eighth month. Return to normal position was resumed by the tenth day postpartum.

Occurring early in pregnancy the recognition of appendicitis is much more simple than later. The importance of its early diagnosis and removal is appreciated when DeLee's cautions[3] are cited. The mistake lies in palliation. It is infinitely better to risk operation on suspicion at this stage, when proper precautions in reducing manipulations of the uterus will practically eliminate the possibility of abortion, than to take the much greater risk in deferring surgery. An exploratory laparotomy should not be withheld until unequivocal evidences of peritoneal irritation portend unnecessary risk to maternal and fetal integrity. Of course in patients with recurring appendicitis an interval operation prior to pregnancy is indicated; but such a procedure cannot be countenanced after conception has occurred.

The difficulty in arriving at a diagnosis increases with advancing pregnancy. Furthermore the chance of complications in the course of an acute appendicitis are greater late in pregnancy. The interruption of pregnancy is never indicated; but appendectomy, as soon as the diagnosis is made, is advised at any stage of gestation.[5] If peritonitis develops, abortion is the

the age of seventeen years and suffered a very unpleasant experience with the midwives who at one time declared her pregnant and in labor. After fourteen days a physician was sent for and "under God's blessing soon restored me." The physician ascertained that she was not pregnant but had suffered some minor malposition of the uterus. Because of this unfortunate experience she studied midwifery and was soon called in consultation by local midwives who regarded her highly. Her reputation increased with the result that she was appointed court midwife. In the course of her practice she took copious case notes in order that she might profit by her clinical experience. Finally, as a result of the urgent entreaties of many of her friends, including the Queen of England—probably Sophia Dorothea (1666–1726), first wife of George I (1660–1727)—she published at her own expense a volume on mid-

Fig. 44.—Facsimile of the engraved title page of *Die Chur-Brandenburgische Hoff-Wehe-Mutter* by Justine Siegemundin, Cölln. a. d. Spree, 1690.

wifery generously illustrated with copper plate engravings[1] (Fig. 44). The major portion of the volume consists of a dialogue between Justine and a pupil, Christina, and is divided into two parts: the first consisting of didactic instruction—the question and answer method—and the second a review, with a reversal of the method, the instructor propounding the questions.

[1] *Die Chur-Brandenburgische Hoff-Wehe-Mutter, das ist: Ein höchstnöthiger Unterricht, von schweren und unrechtstehenden Geburten, in einem Gespräch vorgestellet, wie nehmlich, durch Göttlichen Beystand eine wohl-unterrichtete und geübte Wehe-Mutter, mit Verstand und geschickter Hand, dergleichen verhüten, oder wanns Noth ist, das Kind wenden Könne, durch vieler Jahre Übung, selbst erfahren und wahr befunden, nun aber, Gott zu Ehren un dem Nechsten zu Nutz, auch, auf gnädigst- und inständiges Verlangen, Durchlauchtigst- und vieler hohen Standes-Personen nebst Vorrede, Kupfer-Bildern, und nöthigem Register auf eigene Unkosten zum Druck befördert.* Cölln. a. d. Spree, 1690.

1825), who became professor of midwifery at Göttingen, advocated the extensive use of the midwifery forceps: of 2540 cases of labor 1016 were terminated by means of the forceps. Osiander's teaching may be traced directly to the influence of Levret, although Levret's use of forceps did not begin to approach that of Osiander. **Wilhelm Joseph Schmitt** (1760-1827) of Lorch on the Rhine, adopted the conservative teaching of Boër as contrasted with that of Osiander. Boër's influence spread to Leipzig and Prague where his pupils taught his principles and made further advances in both midwifery and gynecology. Adam Elias von Siebold (1775-1828), professor in Berlin, was the distinguished author of the classical history of midwifery. His son, Ed. Carl Caspar von Siebold (1801-1861), was professor of midwifery at Göttingen. The two Nägeles—Franz Carl (1777-1851) and Hermann Fr. J. (d. 1851)—contributed much to our knowledge of deformities of the pelvis.

Early in the nineteenth century the number of contributions from Germany on the subjects of midwifery and diseases of women notably increased. Among those who contributed largely to the development of midwifery and gynecology based upon a growing knowledge of physiology and pathology may be mentioned Eduard Arnold Martin (1809-1875) of Berlin, Anselm Martin (1809-1883) of Munich, Bernhard Seyfert (1817-1870) of Prague, Karl Schroder (1838-1887) of Berlin, Carl Hecker (1826-1882) of Munich, Robert Olshausen (d. 1894) of Halle, Otto Spiegelberg (1830-1881) of Breslau, Alfred Hegar (b. 1830) of Freiburg—who, as Bass says, performed the first extirpation of normal ovaries (Battey's operation) in 1872—A. Gusserow (b. 1836) of Berlin, and Hermann Beigel (1830-1879) of Vienna.

With the approach of the middle of the nineteenth century, we find German surgeons devoting considerable attention to the pathology of the female pelvis. Rudolph Virchow's (b. 1821) *Archiv* was founded in 1847 and his *Cellular-pathologie* appeared in 1858. A new physiology was in the process of development and Carl Ludwig (1816-1895) was soon to establish his great school with its world-wide influence. Chemistry as applied to the living body, under the leadership of Justus von Liebig (1803-1873), had broken from its inorganic fetters, and with the synthesis of urea at the hands of Friedrich Wohler (1800-1882), a flood of light had illuminated the chemistry of the living organism. Pathologic processes had acquired new meanings and intensive studies of the pathology of the female pelvis naturally followed.

By the middle of the nineteenth century the attention of the medical world was focused upon new discoveries in pathology and physiology emanating from Germany, and with the advent of the science of bacteriology, German contributions, particularly to the etiology of disease, established a high-water mark of scientific advance. German midwifery and gynecology reflected these advances and from 1870 onward the medical world has been under heavy tribute to German investigators in this field. Most of the progress made in Germany was promptly recorded in journals dealing with diseases of the female pelvis, for example, the *Archiv für Gynækologie* (founded in 1870), the *Zeitschrift für Geburtshülfe und Gynækologie* (founded in 1877), and the *Zentralblatt für Gynækologie* (founded in 1877).

measures. Sexton[26] voiced the consensus of American urologists in advising surgery only in the extreme cases. Goedecke[21] objected to such procedures on the grounds that abortion is common thereafter and that the maternal mortality from sepsis and renal insufficiency is appalling by reason of the adverse conditions under which these operations are ordinarily performed. Goedecke's position relative to abortion in these cases as above stated coincided with that of Newell,[27] who urged interruption if the process were of long standing and the subject very toxic. In a word, palliation involves too serious a risk in such patients. Then, too, failure of response to ureteral catheterization and lavage constitutes a further indication for abortion, in his judgment. Finally, he deemed pyelonephrosis, particularly if streptococcic in nature, sufficient grounds for interruption. Newell adjudged vaginal hysterectomy the operation of choice before the sixth month, whereas the induction of labor was preferred later. He professed no objection to cesarean section in the presence of obstruction, although opposition has been cited to this procedure in pyelitis.[16] Crabtree and Prather[13] gave five months as the average period for convalescence from pyelitis after delivery. Pyelonephritis subsides much more slowly and the antecedent history of either of these conditions constitute, in their opinion, a contraindication to subsequent pregnancy until complete recovery bacteriologically and structurally is assured. They also pointed out the necessity for the maintenance of observation and treatment throughout pregnancy by reason of the danger of relighting the neglected infection.

Ureteral Stricture.—Crabtree[28] concluded that ureteral stricture may occur as a legacy of pyelonephritis or ureteritis. He pointed out in addition that it may appear at portions of the ureter where uterine pressure is impossible. Hunner[29] reported a remarkable series of 17 cases in which ureteral strictures were apparently responsible for recurrent abortions.

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INFECTIOUS DISEASES

Typhoid Fever.—With the splendid strides in preventive medicine this problem is fortunately a diminishing one. Nevertheless, typhoid fever constitutes a complication of unusual gravity when it occurs in the course of pregnancy. The older statistics give an incidence of abortion and premature labor of 40 to 60 per cent.[1] Hicks and French[2] maintained that the prognosis and course of the typhoid fever are uninfluenced by pregnancy but agreed to the serious effect of the complicating infection upon the successful conclusion of pregnancy.

One of the most potent factors in the latter connection is the frequent transplacental infection of the fetus. Many reports have substantiated this viewpoint. Lynch[3] reported the presence of typhoid bacilli in a fetus aborted by a patient suffering from typhoid fever. Fetal septicemia, according to this observer, is usually associated with hemorrhagic placental lesions and the death of the fetus. Bolton[4] propounded three possible sources for the agglutinins to be found in the offspring of mothers suffering from typhoid fever, namely, actual transplacental infection, transplacental passage of maternal agglutinins and maternal milk. Talamon and Castaigne[5] related an unusual clinical experience with an infant whose mother developed typhoid fever four months postpartum. A month later while the mother's blood and milk gave positive agglutination tests, the infant's blood after nursing showed a positive Widal test. On weaning, this reaction in the child's blood became less and less pronounced and finally entirely disappeared; but upon resumption of suckling, the agglutinins again appeared in the infant's blood. On the other hand Wichels[6] more recently has determined the mother's milk to be almost free from agglutinins; and in the group of cases which he studied, these antibodies were not found in the blood of the child. The

review of Hicks and French[2] included 21 instances of fetal infection in which typhoid bacilli were found in the blood of the fetus. Two of these subjects were stillborn; hence the infection could have been only transplacental. The positive blood cultures in the fetuses or newborn occurred almost invariably in the clinical cases of typhoid fever appearing late in pregnancy. A parallel case has recently been added to the literature by Wing and Troppoli.[7] The mother with typical typhoid fever was delivered of a 4-pound premature infant. The blood from the umbilical cord showed a positive Widal reaction. The infant's blood showed a similar reaction in a dilution of 1 : 40. The stools of the child were positive for typhoid bacilli.

Prophylactic vaccination against typhoid fever is advised during pregnancy only where the chance of contact is admitted. In periods of epidemics such vaccination should be added to the ordinary hygienic precautions. The management of the actual typhoid fever occurring in the course of pregnancy is directed toward the complication. It is advisable to remove the child from all contact with the mother immediately after birth, although certain authorities suggest the pasteurization and feeding of the mother's milk.

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Cholera.—The most comprehensive study of the complication of pregnancy by cholera was published in 1891 by Schütz.[1] One hundred and twenty-four pregnant and puerperal women constituted the series out of a total of 2500 cases of cholera treated in the Hamburg Staatskrankenhäuser from the end of August to the end of October, 1892. Of this group a third showed some uterine bleeding from endometritis, and amenorrhea for several months succeeding convalescence was not unusual. Feeble labor pains were the rule and the bleeding was not excessive. However, there appeared to be an increased tendency to puerperal sepsis. The maternal mortality was 57 per cent and the disease carried with it a much more serious prognosis in the pregnant than in the nonpregnant subject. Cholera occurring in the puerperium killed 9 of 44 victims.

Uterine contractions occur both in the pregnant and the nonpregnant woman and constitute in Schütz's opinion one of the causes for the common interruption of pregnancy in the former. More important than this, he thought, is the hemorrhagic endometritis which carries with it so grave a risk to fetal life. In his series 54 per cent aborted. Sixty-five of 115 pregnancies terminated either in stillbirth or death of the undelivered fetus. The transmission of cholera through the placenta to the fetus has been reported.[2] Leale[3] wrote one of the few American reports on the subject and stressed

the high fetal mortality. In the surviving mother, there was frequently inadequate milk for the child.

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Undulant Fever.—The devastating results of Brucella abortus infection in the lower animals might well portend similar manifestations in the human. Fortunately abortion has not been a common complication in undulant fever. Samut[1] reported a case of Mediterranean fever in a pregnant woman who aborted on the twenty-first day of her illness. The fetus's blood and cerebrospinal fluid gave agglutination for the causative organism in a titer of 1 : 300 in twenty minutes. The cultures proved negative, leading the observer to question whether the high titer of agglutinins represented a passive transfer of these bodies from the mother or an expression of the defensive reaction of the fetus to an actual infection. Cornell and De Young[2] found agglutinins in the placental blood of a woman aborting at two months; but of 1500 pregnant women only 5 gave faintly positive agglutination tests and 22 women, who had aborted, showed no agglutinative power in the blood. Whitehouse,[3] on the other hand, encountered a case of abortion in a patient where the first thought had been of an ordinary "infected abortion." The woman was the wife of a farmer who had livestock infected with "contagious abortion." The continued fever and a peculiar grayish mucopurulent discharge led to bacteriological studies which revealed Bang's bacilli in pure cultures. Whitehouse set about immediately to check this result; but 50 other cases of abortion proved negative. Simpson and Frazier[4] reported 5 cases of repeated abortions in women without a suggestive infectious or mechanical background. In 4 of these there was elicited the history of obscure undiagnosed fever. All had partaken of raw milk and their titer of agglutinins for Brucella abortus and Brucella melitensis ranged from 1 : 80 to 1 : 320. Scanty lactation may succeed the complicating mastitis.[5] As Whitehouse[3] remarked this infectious cause for abortion must be particularly borne in mind in rural practice and, it should be added, in all drinkers of raw milk.

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Measles.—The complication of pregnancy by measles constitutes a serious hazard both to the mother and to the fetus. Klotz[1] noted the tendency for transplacental transmission of the disease from the mother to the fetus but stated that this rule was not invariable. Interruption of pregnancy by abortion may occur at the height of the mucous membrane

Chickenpox.—Pridham[1] related a clinical experience which lends support to the opinion of transplacental infection of the fetus with chickenpox. Although there had occurred cases of the disease in the family shortly before confinement, the mother had remained healthy and no instance of the disease had appeared for fourteen days before delivery. Nevertheless the newborn child seen four hours after delivery showed an eruption of macules, vesicles, pustules and crusts characteristic of the fourth day of the disease. No new crops appeared and Pridham concluded that the chickenpox had begun in utero.

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Erysipelas.—A streptococcal disease, erysipelas along with all others of this etiologic series carries a serious threat to the mother during pregnancy and the puerperium. The literature on the subject is rather scanty; but Lebedeff[1] has reported the premature delivery of a seven-month fetus whose mother had recovered from erysipelas a week previously. The occurrence of a peculiar skin lesion in the fetus was interpreted as of erysipelatous origin and the probable lymphatic route of the infection from the mother's legs was discussed in detail.

Standard texts[2, 3] include references to isolated experiences with one of several consequences. In facial erysipelas the mother may escape serious complications. Abortion may occur and in the less favorable cases a recrudescence of the pathologic process or a frank septicemia may result. In addition to the usual local measures the antiserum of Birkhaug offers a biological support of uneven value which should not be neglected under these conditions. It is highly important that every aseptic precaution be observed during delivery.

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Anthrax.—The occurrence of anthrax as a complication of pregnancy is extremely rare. Two clinical experiences are especially interesting as examples of transplacental infection. Paltauf[1] reported the isolation of the anthrax bacillus from the lung of a fetus. This organism was also visualized in the alveolar capillaries of the fetal lung. Rostowzew[2] demonstrated fewer and paler staining anthrax bacilli in each of 3 children as compared with the organisms isolated from the maternal tissues. He hypothesized that transplacental migration lowers the virulence of the anthrax bacilli, but admitted that the changes noted might in part be dependent upon the action of maternal antibodies. In each of Rostowzew's cases the maternal infection had entered by way of the face and all were fatal; whereas 3 cases among nonpregnant women terminated favorably.

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Malarial Fever.—Before the discovery of the plasmodia (1880) a diagnosis of malaria was undoubtedly loosely made on the clinical grounds of chills and fever. Certain it is from a review of earlier papers on puerperal malarial fever that most of such cases depended upon septicemia. There has been considerable difference of opinion relative to the influence of malaria upon pregnancy and vice versa. In malarial districts there is wide acceptance of the belief that the disease predisposes to or actually induces abortion. The studies of Blacklock and Gordon[1] upon this question were particularly illuminating. They found placental involvement with malaria in 36 per cent of the women in Sierra Leone; but in spite of this serious infestation there appeared to be no transplacental involvement of the fetus. There occurred a concentration of plasmodia in the placenta, an important consideration, since studies of the peripheral maternal blood frequently failed to reveal these protozoa. Clark[2] had previously called attention to this singular distribution. He found plasmodia in 19 instances in the placenta when only 8 of the group showed them in the peripheral blood; and there was no case of a negative placental study in which the peripheral blood was positive.

Wislocki[3] noted that malaria induces an accumulation of monocytes and lymphocytes in the placental circulation. The monocytes phagocytize the malarial pigment but do not penetrate to the fetal side. Fibrin, which has formed at the site of syncytial denudation, enmeshes these monocytes. The villi with their stroma and covering chorionic syncytium appear anatomically normal and Wislocki concluded that the plasmodia rarely, if ever, cross to induce congenital malaria. Blacklock and Gordon[1] remarked the danger to fetal nutrition from the placental changes but agreed to the rarity of congenital malaria. The clinical experience of Leven[4] must of necessity be rare. A paretic mother was inoculated with tertian malaria as a therapeutic measure. Twenty-two days after the inoculation she was prematurely delivered of an eight-month baby which shortly developed jaundice, anemia and fever. On the twenty-fourth day the hemoglobin was 54 per cent and the erythrocytes 3.9 millions. The plasmodium vivax was found in the infant's blood.

Clark[2] noted the tendency for latent malaria to be activated by pregnancy. Barcroft and his co-workers[5] have demonstrated a marked reduction in the splenic volume during pregnancy. Since the splenic pulp is one of the favorite lurking places for the malarial plasmodia, it is not improbable that the changes described by Barcroft may play an important rôle in dislodging them and in reinitiating the clinical picture of the disease in pregnancy.

As has been stated malaria carries an unusual danger of abortion, stillbirth and early postnatal mortality to the offspring of a malarial mother. Peculiarly, quinine has no apparent oxytocic action under these conditions.[6] Hence it should be used in full therapeutic doses to meet the specific infection.

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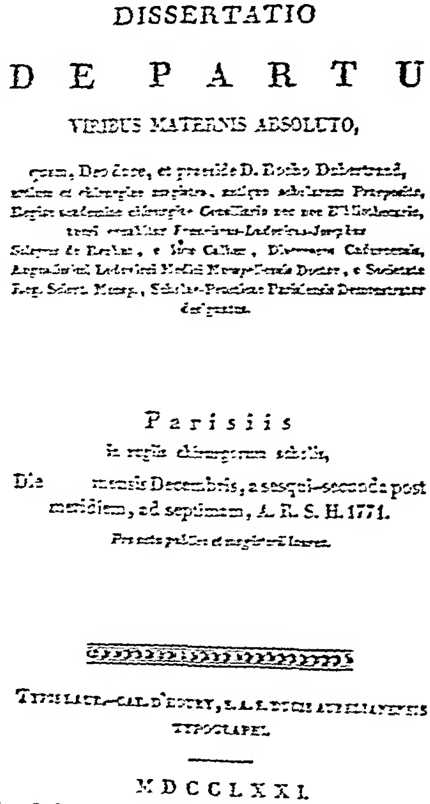
end of several days. Various surgeons were called in and finally M. Solayrès. It had previously been decided to dismember the child in order that the life of the mother might be saved. Baudelocque says:

"At the instant one of the two accoucheurs prepared himself to operate, M. *Solayrès* made the woman lie on the left side to incline the *fundus* of the *uterus* that way, and change the direction of its forces[1]: he took the advantage of the first pains, to raise the child's forehead, which had been pushed down on the left *sacro-ischiatic* ligament,[2] and at the same time direct it towards the *sacrum*: delivery took place immediately, to the great astonishment of the other two practitioners."


DISSERTATIO

DE PARTU

VIRIBUS MATERNIS ABSOLUTO,

Parisiis

Die mensis Decembris, a sesqui-secunda post meridiem, ad septimam, A. R. S. H. 1771.

MDCCLXXI

Fig. 42.—Facsimile of the title page of the *Dissertatio de Partu Viribus Maternis Absoluto* by François Solayrès de Renhac, Paris. 1771. From the *Commentatio de partu viribus maternis absoluto* edited by Caspar Jacob von Siebold, Berolini, 1831. (Crerar Library.)

Solayrès' death occurred in Paris in 1772, the result of tuberculosis.

In addition to his many contributions to the general subject of midwifery, Baudelocque must be connected with the new impetus given to systematic teaching of midwives.[3] As we have noted, most of the midwives in charge of maternity wards in the large French hospitals had by a system of apprenticeship acquired a considerable following and the earliest years of the nineteenth century witnessed the establishment of a midwifery school—the Paris Maternité. The course covered a period of twelve months: the candidates

[1] "The *fundus* of the *uterus* was very much inclined to the right side."

[2] "The head presented so that the *occiput* answered to the right *acetabulum*, and the forehead to the left *sacro-iliac* junction."

[3] Astruc, *q. v.*, p. 85.

1877), A. C. Baudelocque,[1] George Moore[2] (1803–1880), William Campbell[3] (1788–1848), and Edward Rigby[4] the younger (1804–1860). Some few extracts from these writers will show the trend of clinical thought for the first four decades of the nineteenth century.

For example, Robert Gooch says

"It is not uncommon for the greater number of cases to occur in the practice of one man, whilst the other practitioners of the neighbourhood, who are not more skilful or more busy, meet with few or none. A practitioner opened the body of a woman who had died of puerperal fever, and continued to wear the same clothes. A lady whom he delivered a few days afterwards, was attacked with and died of a similar disease; two more of his lying-in patients, in rapid succession, met with the same fate; struck by the thought that he might have carried the contagion in his clothes, he instantly changed them, and met with no more cases of the kind. A woman in the country, who was employed as washerwoman and nurse, washed the linen of one who had died of puerperal fever; the next lying-in patient she nursed died of the same disease: a third nursed by her met with the same fate, till the neighbourhood, getting afraid of her, ceased to employ her. The disease has occurred in some wards of a hospital, the others being free from it; but after ventilating, cleansing, and painting these wards, they became as healthy as the others. Facts such as these have long led to the suspicion that the disease might be communicated from one lying-in woman to another in the clothes of the practitioner or nurse, or the furniture of a tainted chamber."

Again Gooch says in describing the epidemic that occurred in 1824:

"In the winter of the year 1824, puerperal fever was prevalent and fatal in London and its neighbourhood. I had resigned my office at the Westminster Lying-in Hospital, and did not know, or do not remember, what was going on there; but I saw this disease repeatedly in consultation, and heard of it among my medical friends. Several instances occurred of its prevalence among the patients of particular practitioners, whilst others who were equally busy met with few or none. One instance of this kind was very remarkable: a general practitioner in large midwifery practice lost so many patients from puerperal fever, that he determined to deliver no more for some time, but that his partner should attend in his place. This plan was pursued for one month, during which not a case of the disease occurred in their practice. The elder practitioner being then sufficiently recovered, returned to his practice, but the first patient he attended was attacked by the disease and died. A physician, who met him in consultation soon afterwards about a case of a different kind, and who knew nothing of his misfortune, asked him whether puerperal fever was at all prevalent in his neighbourhood, on which he burst into tears, and related the above circumstances."

Auguste César Baudelocque (1795–1851) (a nephew of Jean Louis Baudelocque), whose treatise was awarded the prize of the Royal Society of Medicine of Bordeaux, notes that the introduction of the hand into the parturient canal, and the use of instruments, must be considered in the etiology of puerperal fever—"the influence of which I cannot for a moment contest":

"Peritonitis is to be particularly apprehended, when, during the operation employed for the extraction of the child or placenta, there occurs any laceration of either the vagina or uterus. I will even remark that, in this latter case, or after the Cæsarean operation, the inflammation of the peritoneum is inevitable. . . .

"It would be curious to ascertain in what proportion the disease has declared itself with regard to the number of accouchements effected by the interference of art."

[1] *Treatise on Puerperal Peritonitis.* Translated by G. S. Bedford. New York, 1831.
[2] *An Enquiry into the Pathology, Causes and Treatment of Puerperal Fever*, London, 1836.
[3] *A treatise on the epidemic puerperal fever as it prevailed in Edinburgh in 1821–22. To which is added an appendix, containing the essay of the late Dr. Gordon on the puerperal fever of Aberdeen in 1789, 1790, 1791, 1792.* Edinburgh, 1822.
[4] *A System of Midwifery*, London, 1841.

solution of gastric tissue juice) taken three times a day in water or sweetened orange juice will aid materially in controlling the symptoms.

Considering Treatment for Moderately Severe Forms in Detail.—Whether patients in the mild stage of the condition need further treatment depends in part on the clinical response, the patient's nervous reaction, and the development of dehydration and starvation, or evidence of disturbed or lowered hepatic function. If the patient fails to improve or becomes worse, further measures are necessary. Often rest in bed, seclusion, and proctoclysis properly given, accompanied by increase in the amount of sedative will control the symptoms. A physician cannot temporize if a patient is slow to improve, as suddenly the patient may become seriously ill. Because this not infrequently occurs, many physicians immediately treat the patient who has not responded to the usual ambulatory treatment and whose symptoms become aggravated as a severe case by employing the therapeutic methods outlined below. No criticism of this attitude can be made, for it is better to err on the side of intensive treatment than to fail to appreciate the seriousness of the condition.

Considering Treatment for Severe Forms in Detail.—When the diagnosis is made of hyperemesis in a severe stage the patient is placed on a systematic regimen, preferably in a hospital. The chances of securing adequate isolation in the home are minimal; control of the patient and the patient's environment, even under the best conditions at home is not as absolute as can be secured in the hospital. The value of this control is often underestimated and may prove to be a deciding factor in the failure of treatment. A definite regimen is important to the ambulatory or mildly affected patient, but becomes increasingly so to the patient with symptoms of starvation and dehydration. Very guarded and careful treatment is necessary, for the condition may progress insidiously from the stage of mild starvation and dehydration to a serious condition in which symptoms of lowered hepatic reserve or disturbed hepatic function become evident. Under ideal conditions the patient is placed in a room by herself and is seen only by her nurse and physician; all visitors are forbidden, even her husband's visits are to be curtailed, and the reason explained to him. Much depends on the nurse. She should understand in general the principles involved in the treatment of these patients, and carry a quiet air of confidence and efficiency without being over-efficient. On admission to the hospital, the patient is put to bed, and in the event that physical examination has not previously been done; this should be carefully and thoroughly carried out. A specimen of urine is examined microscopically, and for specific gravity and amount, and for presence of sugar, albumin, acetone, diacetic acid and urobilin; thereafter, all urine voided during each twenty-four hours is saved, measured, and subjected to the same examination. If possible, examination of the blood is made to determine the amount of nonprotein nitrogen, blood chlorides, sugar, and serum protein, and the carbon dioxide combining power is determined. Examination of the ocular fundi is desirable and should be repeated from time to time, for it offers an index of the patient's condition, much as it does in late toxemia of pregnancy. Any evidence of retinitis is to be considered as an adverse sign. If any local treatment, such as that of an infected cervix, or of a retroverted uterus is indicated, it should be done in order that during the subsequent few days there may be as little disturbance

of the patient as possible. The patient is then given a thorough cleansing enema, taking particular pains to ensure complete return of the injected fluid, and to be sure that the colon is thoroughly evacuated. All food, fluid, and medication by mouth is probably best prohibited for twenty-four to forty-eight hours. Harding and Van Wyck[30, 31] advised free use of fluids, especially water, at this time. They gave it as their opinion that even though vomiting occurs, some fluid is retained.

Attention is paid to the oral hygiene of the patient. The mouth should be thoroughly cleansed twice daily, and may be rinsed out with an alkaline mouth wash at frequent intervals. This is important because in many of these patients, unless they are closely watched, a state of poor oral hygiene develops, which is often a source of irritation.

The essentials of treatment are to combat nervous irritability and to supply a positive amount of food and fluid to the patient. She has demonstrated her inability to keep up the supply by mouth, hence that route is perhaps to be abandoned temporarily. Four avenues remain: Proctoclysis, intravenous injection, hypodermoclysis, and food by duodenal tube. The choice must depend on equipment and facilities at hand. If properly prepared solutions are available, the intravenous method is most desirable, for by this means a controlled amount of dextrose and fluid, the two greatest needs, can be supplied. Large amounts of fluid can, however, be absorbed by these dehydrated patients if given by hypodermoclysis, and if intravenous medication is not at once available this method should be used. It is to be remembered, however, that very dilute solutions, not over 3 per cent, of dextrose should be given hypodermically because of danger of local reaction with necrosis of tissues. Saline may be administered freely in this manner. Proctoclysis remains a valuable means of administering both dextrose and fluid, and is successful in many cases.

When the patient ceases to be ambulatory, it is often necessary to increase the amount of sedative. At this time it is usually not advisable to attempt oral administration, but sedatives are given by proctoclysis, hypodermically, or occasionally intravenously. The use of morphine should be avoided, for it nauseates many patients. Phenobarbital sodium (luminal sodium) may be given hypodermically, bearing in mind that its action is usually delayed eight to twelve hours.

In Initiation of Treatment at this Stage, Dependence may be Placed on Sedatives Administered in the Rectally Injected Fluid.—Bromides, 90 to 120 grains (6 to 8 Gm.) are dissolved in each 1000 cc. of fluid for the first few days, gradually diminishing the amount of sedative as the symptoms improve. This is often sufficient, in combination with the fluid and glucose, to control the condition. Thirty grains (2 Gm.) of chloral hydrate may be substituted for the bromides, or 1 to 2 drachms of compound tincture of opium can likewise be used for patients whose colons seem particularly irritable. For patients who are difficult to control and for whom intravenous treatment is employed, $1\frac{1}{2}$ grains (0.1 Gm.) of pentobarbital sodium may be given in 1000 cc. of the solution that is given intravenously.

Details of Special Procedures.—1. The administration of solutions by way of the bowel may be undertaken by several methods. In the Murphy drip, the drops of fluid can be seen, and the rate of flow judged. The tidal flow method may be used. In this apparatus the reservoir is adjusted to

such a height that the level of fluid in the bowel and in the reservoir is the same; free to-and-fro motion between them is possible. This avoids discomfort to the patient, and allows expulsion of gas at the same time, keeping a constant amount of fluid in the colon. Some physicians prefer giving fluids by means of repeated, small retention enemas of 200 to 300 cc., repeated as often as necessary.

Certain essentials should be observed in giving fluids by colon, regardless of the method employed. A thorough cleansing enema should be given first. If the colon and rectum contain fecal matter, the fluid is often poorly tolerated or expelled. Absorption from a clean colon is more certain, and the rate probably more rapid than if the fluid is diluted by the fecal content. After the cleansing enema is given it is preferable to wait thirty minutes to one hour before starting proctoclysis. If patients are very nervous and restless, some sedative should precede insertion of the colonic tube. A rectal suppository, containing 1 grain (0.065 Gm.) of opium and $\frac{1}{4}$ grain (0.016 Gm.) of belladonna or a sufficient amount of paregoric may be used. A sufficiently long tube should be employed to insure reaching the colon. This is best inserted under guidance of a finger in the rectum, to be sure that there is no coiling in the rectum. Should this occur, the rectum fills and the patient has difficulty in retaining the solution. In addition, absorption from the rectum is not nearly as efficient as it is from the colon.

The solution for administration by proctoclysis should afford an optimal amount of glucose with sufficient sedative in a medium that will cause the minimal amount of irritation. We have found that a solution of dextrose, 5 or 10 per cent, in physiologic solution of sodium chloride answers very well, or commercial corn syrup can be used in proper solution. At the beginning of treatment, between 90 and 120 grains (6 to 8 Gm.) of sodium bromide is dissolved in each 1000 cc. of the mixture. For the first forty-eight hours as much solution is administered as the patient will tolerate, and the proportion of bromide is maintained. Thus, the three essentials of treatment are fulfilled: Dextrose is given to supply nourishment and to combat the deficiency in glycogen; fluids are administered to replace those lost by the previous dehydration, and sedatives are employed to relieve the nervous irritability, together with chlorides to replace those lost by excessive vomiting. Even if this treatment was kept up for several days, we have never seen a bromide rash in the patients. The exact method of performing proctoclysis will vary with the individual patient. If the enema is well tolerated during the day, and sufficient fluid is taken, it is often well to discontinue the administration at night. This removes a source of disturbance to the patient, and also reduces the likelihood of the colon becoming irritable. If toleration is poor during the day, administration may be kept up for two hours, discontinued for one hour, and so on.

The posture of the patient is important, although in our opinion proper preparation of the colon is more so. If the colon has been well prepared, patients often can lie on the back with good results. In other cases, a pillow may be placed under the hips to elevate slightly the lower part of the bowel; this prevents the solution from returning into the rectum to be expelled. The Sims position with the patient lying on the left side is of advantage because of the anatomical position of the sigmoid and descending colon.

of the hospital, Collins was twenty-six years of age, having graduated in medicine from Glasgow in 1822. He succeeded Pentland, who had died in office after a service of not quite five years. Although Collins' mastership expired in November, 1833, he did not publish his report[1] (Fig. 56) until 1835. This work impresses the reader with the author's absolute sincerity and honesty. The style is clear and precise. The statistical tables are examples of painstaking care and the author is utterly frank in acknowledging mistakes. The most startling pronouncement is that in which he relates his experiences with *chlorine disinfection.* When Joseph Clarke was master he had given the

Fig. 55.—Robert Collins. (From the author's collection.)

hospital a thorough cleaning on the first appearance of puerperal fever, having recourse to "the expensive and troublesome process of painting, etc.," and "every symptom of fever subsided as the patients were received into clean wards." Describing the cleanliness exercised by Labatt in one of the earlier epidemics during his mastership, Collins says:

> "In the epidemic of 1819 and 20, the most scupulous and unwearied attention was paid to cleanliness, ventilation, etc. by Doctor Labatt, who was then Master; every effort, however, was insufficient to check the disease for a considerable time. In one instance a ward, in which there had not been any patients for several months, and which had been in the meantime kept strictly clean and well aired, was opened, and five patients admitted, three of whom were seized with the fever, and two died."

[1] *A Practical Treatise on Midwifery, containing the result of Sixteen Thousand six hundred and fifty-four Births, occurring in the Dublin Lying-In Hospital, during a period of seven years, commencing November, 1826.* London, 1835.

follows: The weighed dextrose is dissolved in a small amount of hot, sterile, triple distilled water, and the solution is filtered with suction through a funnel of Buchner type, to remove any impurities; the filtrate is poured into the sterile pyrex glass; a small excess of sterile water is added, more than the amount necessary to make a solution of the proper strength. It is then concentrated to its proper volume by boiling for ten to fifteen minutes. The solution is not sterilized in the autoclave, but care is taken while the dextrose solution is boiling not to allow the dextrose to dry on the side or bottom of the container. Solutions of dextrose that have stood more than eight hours, other than in sealed containers, should not be used. Commercial ampules of dextrose in concentrated solution, to be diluted with distilled water, are now obtainable.

Assuming that dextrose has been properly prepared, the injection should not be attended with untoward results. Perhaps too little emphasis has been placed on the proper administration. Thalheimer, Titus, Dieckman and Crossen, and others have developed by careful study a satisfactory technic, and their freedom from reactions demonstrates the need of a uniform technic of administration of dextrose solutions. The apparatus should be sterilized, separately, and absolute care used to avoid contamination. New rubber tubing is very likely to produce toxic material. Pure gum tubing without bloom should be used. To insure the removal of any toxic material, new tubing is heated in 0.5 per cent sodium hydroxide solution, and care is taken that the inside is well cleaned by kneading the tubing between the hands. The sodium hydroxide is removed by washing well in distilled water and allowing the distilled water to run through the tubing for several hours.

The temperature of the solution should be maintained at 40 to 42 C. throughout the injection. Often the solution is at this temperature when the injection begins, but as the injection proceeds the solution cools off materially. It has been found that a temperature below 37 or above 45 C. is likely to be associated with a reaction. Various types of apparatus have been devised to maintain the temperature, among which may be mentioned those of Thalheimer and of Titus. The temperature can be maintained by a waterjacket around the glass reservoir, by hot water bottles placed along the rubber tubing, and then the result watched, by means of a thermometer placed in the rubber tubing next to the needle.

From one hour to one and one-half hours should be consumed for injection of 1000 cc. of 10 per cent dextrose solution. This means that 100 Gm. of dextrose is given during this period. With higher concentrations of dextrose, a correspondingly longer period of time should be taken for the injection; in other words, the length of time taken for intravenous administration depends on the amount of dextrose given, more than on the amount of fluid. This slow injection is needed in order that the pancreas may have sufficient time to produce the necessary insulin. Ordinarily, 1000 cc. of 10 per cent solution is to be given three times a day, or 1500 cc. may be given twice a day. If a 20 per cent solution is used, 500 to 1000 cc. is given twice a day.

3. Opinion is rather sharply divided as to the use of insulin. Thalheimer has advocated the use of insulin on the basis that the acidosis in severe vomiting of pregnancy is due not only to a deficient supply of carbohydrate,

Through the assistance of Dr. John Roberton (1797–1876), one of the surgeons of the Manchester Lying-in Hospital, Henry was supplied with fresh vaccine lymph "taken from pustules of unequivocable character." This material Henry subjected to heat for periods of two to four hours after which healthy children were inoculated. As a result he showed that vaccine lymph heated for a period of from two to four hours at a temperature not below 130 F. was rendered inert. Three experiments of this character are recorded, all with the same result.

A second series of experiments was undertaken with the cooperation of Mr. William Marsden (1796–1867), house surgeon of the Manchester Royal Infirmary, and specimens of vaccine lymph heated for two hours at 150 F., four hours at 150 F., two hours at 172 F., four hours at 172 F., all proved inert. Lower temperatures were then tried and it was found that a temperature of 120 F. continued for three hours did not decrease the virulence of the vaccine lymph.

Henry then constructed a chamber made of copper consisting of an inner and outer shell, the space between the shells so arranged that steam could be admitted. Stopcocks were provided for the discharge of condensation, and the escape of surplus steam. This apparatus he recommended for the sterilization of all articles known to have been in contact with patients ill with contagious disease. Concluding his article he says that he does not propose to supersede the employment of chemical disinfectants, particularly that of chlorine.

A subsequent article[1] by William Henry sets forth his experiments with typhus and scarlatina. In the first disease, clothing that had been in contact with a patient was exposed to a temperature slightly in excess of 200 F. for one hour and three quarters, and was thereafter worn next the body of a healthy individual for two hours without injurious effect.[2] In scarlatina, a disease which Henry says "no one doubts of its being infectious," clothing worn next the body of acutely ill patients was heated four and one-half hours at 204 F. and shortly thereafter was worn by a boy (age six years) for a period of one week with no appearance of the disease. Articles of clothing from other acutely ill cases of scarlatina, that had been heated at a temperature of from 200 to 204 F. for a period of two and three-quarter hours, were worn by the same volunteer who remained perfectly well. In all, four different volunteers remained perfectly well subsequent to wearing sterilized clothing that had been in contact with acutely ill scarlet fever cases.

From this Henry concluded that

> ". . . by exposure to a temperature not below 200° F. during at least one hour the contagious material of scarlatina is either dissipated or destroyed."

Again he says:

> "I think it demonstrable that the disinfecting agency belongs to heat alone."

To this article he appends an illustration with a description of his apparatus.

[1] *Further experiments on the disinfecting powers of increased temperatures. Philosophical Magazine*, vol. xi, 1832, pp. 22–31.

[2] Probably the earliest instance of delousing.

Fieber und die Kindbett-Fieber (1837) (Fig. 58)—deserve attention inasmuch as from *a priori* reasoning based on extensive perusal of the literature, Eisenmann approached very closely to the true etiology and prophylaxis of puerperal fever. Both works are marvels of theoretical deduction and were written while he was in prison. At the time Eisenmann had had comparatively little clinical experience.

Eisenmann was a man of exceptional mentality. At the age of fifteen he began the study of law which was interrupted three years later when he entered military service. In 1815 he changed his plans abruptly and entered upon the study of medicine. He received his degree in 1818 and located at

Die

Wund - Fieber

und die

Kindbett - Fieber.

Beschrieben

von

Dr. Eisenmann.

Erlangen, 1837

bey J. J. Palm und Ernst Enke.

Fig. 58.—Facsimile of the title page of *Die Wund-Fieber und die Kindbett-Fieber* by Gottfried E. Eisenmann, Erlangen, 1837.

Würzburg in 1822. Within a year thereafter, because of his political activities, he was arrested and imprisoned for a period of two years. He later turned his attention to practical politics and in 1828 published a political journal. For a time he was in the good graces of the authorities. With the political upheaval of 1832, however, his paper was suppressed and he was convicted and sentenced to prison for a term of fifteen years. During this period of incarceration he prepared several monographs on medical subjects. In his prophylactic régime (*Die Kindbett-Fieber*), Eisenmann recommends the use of powdered chlorinated lime with phosphoric acid. The action of bacteria, had Eisenmann known about bacteria, is very well described in the following lines:

allowed to reach a state of dehydration and starvation, such that unalterable changes have occurred in the tissues, and death is inevitable regardless of any treatment. As a rule, it is probable that among those patients who recover their metabolic equilibrium, the response to treatment should be prompt. However, if in spite of adequate intensive treatment vomiting persists, dehydration and evidence of starvation, with dry skin, do not disappear, the pulse rate persists in remaining high, fever develops, and jaundice appears, interruption of pregnancy must be considered. Persistent urobilinuria and continued low serum protein are likewise adverse signs. As previously mentioned, examination of the ocular fundi is of value. A normal appearing fundus is to be expected in the usual case, but if retinal changes appear, abortion should no longer be delayed.

Therapeutic Abortion.—Emptying of the uterus remains the last therapeutic agent to be considered in the treatment of hyperemesis gravidarum. To state exactly when this will become necessary is, as a general rule, impossible. The physician who has been following the individual case carefully, noting the signs of progress and of severity, will have his judgment greatly taxed to determine the time for terminating the pregnancy. No doubt most women who die of hyperemesis could have been saved, had the pregnancy been terminated early enough. On the other hand, it is equally certain that too early interruption will needlessly terminate many other pregnancies. Persistent progress of the disease, in spite of adequate treatment under controlled conditions, should lead one to consider interruption.

Many of the diagnostic features used as indications for therapeutic abortion really represent an advanced condition of the disease, in which even emptying the uterus will not save the patient.

The method of emptying the uterus should carry a minimal amount of trauma and shock to the patient. Complete asepsis is absolutely essential. These women are easily infected and tolerate infection poorly. In the primigravida, with a long, firm cervix, one may need primarily to pack in order to soften the cervix, so that dilatation can be carried out with a minimal amount of laceration. Frequently, introduction of a bougie or of a retention catheter will initiate abortion. If the cervix can be dilated, the operation of dilatation and curettage in the first trimester can often be done. After the third month, the products of conception may attain a size which renders removal through the cervix difficult, and vaginal hysterotomy may have to be done. Supportive treatment should be continued during the time of emptying the uterus and for a period thereafter.

TOXEMIAS OF THE LATER MONTHS

Preeclamptic toxemia has been subdivided by obstetricians, and to the various subdivisions various terms have been applied. In a measure the significance of these terms will be considered in the section of this chapter which deals with the toxemia of the later months of pregnancy. However, in this chapter we have adopted the terms "preeclamptic toxemia" to include all types of the condition, "mild preeclamptic toxemia" to include the less severe forms, and "severe preeclamptic toxemia" to include that form which is seen when eclampsia is imminent. Some obstetricians use the term "preeclamptic toxemia" without any modifying adjective, or the term "low reserve kidney" to indicate the condition which we are calling "mild pre-

eclamptic toxemia." Commonly, the term, "preeclampsia" is used to indicate the condition which we are calling "severe preeclamptic toxemia."

Chronic nephritis complicating pregnancy has so many symptoms similar to those of the acute toxemias that it seems proper to consider it in a discussion of these conditions. Chronic nephritis is not a toxemia peculiar to the later months of pregnancy and use of the term "chronic nephritis" indicates that the lesion has existed prior to the pregnancy it complicates. However, the behavior of the kidneys with chronic nephritis is affected by pregnancy in a distinctive manner and the resulting symptoms, especially in the milder forms, frequently are not capable of differentiation from the true toxemias. In fact, in many instances a "quiescent" or "occult" chronic nephritis undetected by any clinical or laboratory tests known at present may be revealed only by the "test of pregnancy." An additional reason for including chronic nephritis in a consideration of the toxemias of pregnancy rests on the production of symptoms of nephritis which may later become chronic during the course of many "true" toxemias.

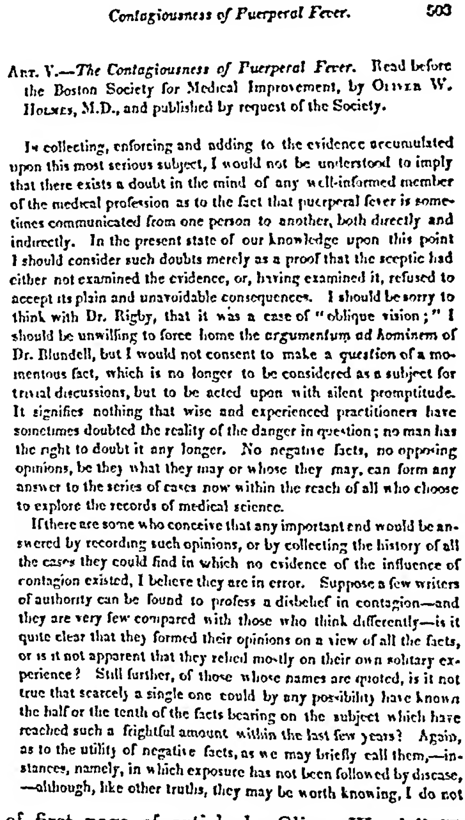
CHRONIC NEPHRITIS

Chronic nephritis is a relatively frequent complication of pregnancy. It is not truly a toxemia of pregnancy, for the renal injury antedates the pregnancy. There is a marked tendency for chronic nephritis to be aggravated during pregnancy, however, and increase in severity may be produced by the same toxic agent that causes the acute toxemia. Usually, symptoms of the exacerbation of chronic nephritis become evident before the third trimester of pregnancy but when the nephritis is more advanced these symptoms may appear early. More rarely, chronic nephritis, previously undiagnosed by clinical or laboratory tests, may be revealed only by symptoms appearing in the course of pregnancy. Chronic nephritis comprises 26.7 per cent of the cases classified at Johns Hopkins Hospital by Stander as cases of toxemia of pregnancy. Gibberd reported 51 cases in which the patients were observed through at least two pregnancies at Guy's Hospital; the first pregnancy was associated with "albuminuria." Four of the patients had chronic nephritis prior to the first pregnancy. Among 97 patients with toxemia delivered by us at St. Mary's Hospital, only 7 per cent had chronic nephritis prior to pregnancy.

Etiology.—Chronic nephritis which exists prior to any given pregnancy may follow a contagious disease of childhood, such as scarlet fever, or may be the result of some infectious focus such as may be present in the tonsils or teeth; or the renal injury may have been caused by previous toxemia of pregnancy. In fact, experience has shown that preeclamptic toxemia is by no means a small factor in production of chronic nephritis, and that frequently the injury to the kidney is increased by each subsequent pregnancy. In six of Gibberd's cases in which albuminuria was noted an average of nine weeks prior to termination of pregnancy, chronic nephritis developed. Thirty-three of our toxemic patients, none of whom had preexisting nephritis, were observed through one or more subsequent pregnancies. Eight patients gave definite evidence of a more or less severe grade of chronic nephritis, and seven manifested suggestive but not conclusive evidence of chronic nephritis. Caldwell and Lyle reported an incidence of chronic nephritis of 8 per cent after eclampsia. Gibson found that in 5 of 14 cases of eclampsia

but were more forcefully stated, more definite and more accurate. Had Holmes' rules been followed to the letter by practitioners of midwifery the world over, the incidence of puerperal fever would have been tremendously reduced. Holmes cites the suggestive experience of one of his correspondents who during an epidemic of puerperal fever in his practice changed his clothes and washed his hands in chloride of lime after each visit. He then attended seven women in labor during this period, none of whom was ill.

The career of Oliver Wendell Holmes is so familiar as to require no detailed narration. His natural predilection for literature and his teaching



Contagiousness of Puerperal Fever. 503

ART. V.—*The Contagiousness of Puerperal Fever.* Read before the Boston Society for Medical Improvement, by OLIVER W. HOLMES, M.D., and published by request of the Society.

In collecting, enforcing and adding to the evidence accumulated upon this most serious subject, I would not be understood to imply that there exists a doubt in the mind of any well-informed member of the medical profession as to the fact that puerperal fever is sometimes communicated from one person to another, both *directly* and indirectly. In the present state of our knowledge upon this point I should consider such doubts merely as a proof that the sceptic had either not examined the evidence, or, having examined it, refused to accept its plain and unavoidable consequences. I should be sorry to think with Dr. Rigby, that it was a case of "oblique vision;" I should be unwilling to force home the *argumentum ad hominem* of Dr. Blundell, but I would not consent to make a *question* of a momentous fact, which is no longer to be considered as a subject for trivial discussions, but to be acted upon with silent promptitude. It signifies nothing that wise and experienced practitioners have sometimes doubted the reality of the danger in question; no man has the right to doubt it any longer. No negative facts, no opposing opinions, be they what they may or whose they may, can form any answer to the series of cases now within the reach of all who choose to explore the records of medical science.

If there are some who conceive that any important end would be answered by recording such opinions, or by collecting the history of all the cases they could find in which no evidence of the influence of contagion existed, I believe they are in error. Suppose a few writers of authority can be found to profess a disbelief in contagion—and they are very few compared with those who think differently—is it quite clear that they formed their opinions on a view of all the facts, or is it not apparent that they relied mostly on their own solitary experience? Still further, of those whose names are quoted, is it not true that scarcely a single one could by any possibility have known the half or the tenth of the facts bearing on the subject which have reached such a frightful amount within the last few years? Again, as to the utility of negative facts, as we may briefly call them,—instances, namely, in which exposure has not been followed by disease,—although, like other truths, they may be worth knowing, I do not

Fig. 60.—Facsimile of first page of article by Oliver Wendell Holmes in *New England Quart. Jour. Med. and Surg.*, 1843, vol. i, p. 503.

fully occupied his time and at a comparatively early date he relinquished active practice. With the establishment of the *Atlantic Monthly* came the *Autocrat of the Breakfast Table* papers, and Holmes' position in world literature was established. Although hailed throughout America as a great poet and essayist, Holmes held a lurking pride of accomplishment in his puerperal fever essay. In a letter addressed to his friend, Dr. James R. Chadwick (1844–1905), librarian of the Boston Medical Library, Holmes writes under date of May 8, 1883:

"It is just fifty years since my essay on the contagiousness of puerperal fever was published in the *New England Journal of Medicine and Surgery.* It had been previously

"The result of the whole discussion will, I trust, serve not only to exalt your views of the value and dignity of our profession, but to divest your minds of the overpowering dread that you can ever become, especially to women under the extremely interesting circumstances of gestation and parturition, the minister of evil; that you can ever convey, in any possible manner, a horrible virus so destructive in its effects and so mysterious in its operations as that attributed to puerperal fever."

For many years following 1843, American medical writers published numerous papers on the contagiousness of puerperal fever and ample evidence was supplied through case citations, to support Holmes' position.

In an article read before the Sheffield Medical and Surgical Society[1] Robert Storrs, of Doncaster, maintained that

". . . puerperal fever once set up is again capable of imparting to many persons not in the puerperal state by actual contact or close approximation, the following diseases.

"1s. Inflammation of the peritoneum or other serous membranes, accompanied by low fever, both in the male and female subject.

"2d. Erysipelas; local, as in the hand or arm, from *postmortem* inspections; or general, as in the face or person.

"3d. Typhus fever, with its various accompaniments, and in a variety of forms."

In support of the above conclusions numerous clinical cases are cited, most of which are from his own practice. The position of Dr. Storrs was supported in a later article by Dr. James Reid[2] in which he cites a fatal case of erysipelas in the husband of a woman ill with puerperal fever. It appears that the husband had occupied the same bed with the wife.

Samuel Kneeland[3] (1821–1888) in his article, *On the Connection between Puerperal Fever and Epidemic Erysipelas, in its origin and mode of propagation*[4] notes that erysipelas frequently attacks a patient where there has been a break in the skin: "a solution of continuity." He describes the observations of the French obstetrician, Paul Dubois[5] (1795–1871) who found, on making a careful examination of the vulva, vagina, and cervix following delivery, small rents and lacerations, the mucous membrane being almost always more or less detached, "the neck of the uterus soft, flaccid and torn to a considerable extent." He says:

"This condition is so universal, that there is no surer criterion by which to judge that a woman has had children, than by the cicatrices of these little wounds."

Kneeland calls attention to the fact that a wound is frequently present after delivery and says

". . . you have exciting causes enough to call forth the latent poison of erysipelas."

[1] Published in the *Provincial Medical and Surgical Journal*, May 7, 1845.

[2] *London Medical Gazette*, 1845.

[3] Samuel Kneeland received his M. D. from Harvard Medical School in 1843. After two years of medical study in Paris, he began the practice of medicine in Boston. In 1846 he was awarded the Boylston prize for his essay *On the Contagiousness of Puerperal Fever.* Following his service as a surgeon during the Civil War he became professor of zoology and secretary of the Massachusetts Institute of Technology.

[4] *American Journal of the Medical Sciences*, n. s., vol. xi, 1846.

[5] Paul Dubois greatly advanced the science of obstetrical auscultation. In 1825 he was made professor and surgeon-midwife to the Paris Maternité. He published *La fièvre puerpérale de la Maternité*, 1841, *Lancette française*, Nr. 85; and *Discours prononcés à l'Académie impériale de médecine, dans la discussion sur la fièvre puerpérale*, Paris, 1858.

patients who had been under our observation and care during the prenatal period. The subject of prenatal care is ably presented in another chapter but a consideration of the treatment of preeclamptic toxemia would not be complete without emphasizing the important part which adequate prenatal care plays in the prophylaxis of cases of toxemia of the later months of pregnancy.

Every pregnant woman should be given a thorough examination if possible not later than the third month of gestation. It has been suggested that cases of preeclamptic toxemia are more common among short, stocky, heavy-boned women who are inclined to be overweight. If so, patients of this type should be observed all the more carefully; in addition to the physical examination, examination of blood, and pelvic measurements, search should be made for possible foci of infection. Talbot and others have advanced the hypothesis that most cases of preeclamptic toxemia are caused by toxins or organisms which gain access to the system from infected tonsils, teeth, or other foci. Although the part played by infection in the etiology of preeclamptic toxemia is disputed, it has not been entirely disproved. As infection is known to be a factor in the production of other complications of pregnancy, such as pyelonephritis, evident foci can be removed prior to pregnancy, between pregnancies, or even in the course of pregnancy. When foci are removed in the course of pregnancy it is advisable to remove them before pregnancy is far advanced.

At the first examination and subsequent examinations, blood pressure and weight are recorded, urinalysis is made, and the presence or absence of edema is recorded. If the patient has had nephritis in a previous illness, or if she has had preeclamptic toxemia in a previous pregnancy, or if hypertension, albuminuria, or edema is found, tests of renal function and examination of the ocular fundi should be made. If a diagnosis of chronic nephritis is made, or if even a strong suspicion of the presence of this disease is entertained, treatment described in the consideration of chronic nephritis is instituted.

If the patient gives no evidence of nephritis she is advised to present herself for examination at least once a month up to the seventh month, and then every two weeks or more often if necessary. A general diet is prescribed, the bulk of which consists of fruit and vegetables, milk (at least three glasses daily), carbohydrates, a reduced amount of fat and protein (one ordinary helping of meat and one egg daily) and a minimal amount of salt and spice. The diet is regulated from time to time to limit the gain in weight to not more than 20 to 25 pounds during pregnancy. The patient is advised to drink from six to eight glasses of water daily, and to regulate the bowels properly. She is urged to report to her physician the presence of edema, disturbance of vision, dizziness, or unusual headaches.

If patients follow carefully such a regimen, comparatively few cases of preeclamptic toxemia will develop, and these usually will be observed early enough for treatment to be instituted and for more advanced forms of preeclamptic toxemia to be prevented.

When signs of incipient preeclamptic toxemia develop, such as rising blood pressure, undue gain in weight, edema, or albuminuria graded 2, certain definite instructions should be given aimed at limitation of physical activity, avoidance of chilling, reduction of diet and promotion of elimination.

The patient is impressed with the importance of lessened physical and mental activities, for these tend to increase hypertension and albuminuria. Ingestion of protein is limited to not more than 50 Gm. daily, and the total amount of food ingested is reduced sufficiently to prevent gain in weight, or even, in some instances, to cause reduction in weight. Adequate intake of vitamins is maintained by milk, vegetables, and fruit or fruit juices, except temporarily, if more limited diet is indicated. The intake of salt is reduced to a minimum, and the patient is urged to take laxatives daily if necessary for free evacuation of the bowels. She is advised to abstain from or greatly to lessen the use of tea or coffee. If edema is present the intake of fluids is not increased or may even be limited until the output of urine increases and edema lessens.

If the symptoms of preeclamptic toxemia increase, or if the condition is more advanced when the patient consults her physician for the first time, she is put to bed, preferably in a hospital. A rise of systolic blood pressure to more than 140 mm., especially if accompanied by albuminuria graded 2 or more (more than 20 mg. of albumin per liter) occurring in a case in which the regimen has been one of reduced diet and exercise, indicates the advisability of rest in bed. In addition to readings of blood pressure and urinalyses, the blood is examined, if laboratory facilities are available, for increased retention of nonprotein nitrogen or urea, for the estimation of chlorides if edema is present, and in the more severe cases, for carbon dioxide combining power, to determine the presence or absence of depleted alkali reserve. When possible, inspection is made of the ocular fundi to determine the presence or absence of arteriolar involvement. Repeated examinations of the eyegrounds may reveal changes; such changes constitute an excellent index to progression or regression of general arteriolar involvement, and incidentally a fair index of the degree of preeclamptic toxemia.

The treatment will depend on the severity of the symptoms, and the rapidity with which they have progressed. If the preeclamptic toxemia is of moderate severity the patient is confined to bed and is given sufficient sedative to promote sleep and relieve restlessness. Many useful sedatives are available, among which are the following: Bromides, given in doses of 60 grains (4 Gm.) by mouth or in doses of 100 or even 150 grains (6.5 or even 9.75 Gm.) by rectum daily; chloral, 20 to 30 grains (1.3 to 2 Gm.) daily; the derivatives of barbituric acid such as pentobarbital sodium or sodium iso-amylethyl barbiturate (sodium amytal) in doses of 3 grains (0.2 Gm.) by mouth, and small doses of morphine if other sedatives fail. A diet, prepared without salt, containing between 1000 and 1500 calories daily, with a low content of protein (about 50 Gm.) is given. If edema has developed the daily intake of fluid is limited to from 800 to 1000 cc. until the edema has greatly lessened or disappeared. Various other diets are recommended. Volhard and Zangemeister, and Baumgart (quoted by Seitz) advised withholding food and fluids for two to three days, followed by a diet similar to that mentioned above. If the patient is greatly overweight and has marked edema, such a procedure is rational, for she has sufficient excess of tissue food and fluid to care for her needs for several days. Pinard advised a strict milk diet, and there is some merit in this, although the content of protein is high if the patient takes enough milk to maintain strength. Tweedy reported good results on a starvation diet for three or four days with free intake of

"But puerperal fever is conveyable (übertragbar) from a sick pregnant, parturient or puerperal woman to a healthy pregnant, parturient or puerperal woman by means of a decomposed material produced by the sick pregnant, parturient, or puerperal woman. Puerperal fever is not conveyable during life from every sick pregnant, parturient, or puerperal woman to a healthy individual, but only from those infected women who produce a decomposed material. After death puerperal fever is conveyable from every cadaver of a puerpera to a healthy individual when the cadaver has reached the necessary degree of decomposition."

We must now add another paragraph to the Lehre of Semmelweis:

Lehre V. (a) Puerperal fever may be conveyed to a woman subsequent to delivery through the presence in the same hospital of surgical cases producing putrid products.

(b) The puerperal woman may also infect herself owing to the retention within the birth tract of material which has undergone decomposition.

(c) Instrumental injuries, bruising or causing gangrene of the genital tract, may produce puerperal fever by self infection.

Relative to the fairly widespread practice among English obstetricians of changing their clothes, bathing, etc., Semmelweis says:

"I and the students in Vienna in 1848 never changed our clothing after being occupied with things possessed of properties which made them capable of producing childbed fever; we only thoroughly disinfected our hands by chlorine washing, and in the year 1848 we lost only 45 patients out of 3556, that is, in the proportion of 1.27 per cent!"

With reference to the ventilation of the lying-in wards and isolation of infected cases so strongly insisted upon by White, Clarke, Collins, and others, Semmelweis makes no mention until the publication of his *Aetiologie* in 1861, in which he says:

"The conveyer of the decomposed matter may also be the atmospheric air. Hence free ventilation is necessary to carry away from the lying-in wards the exhalations from patients before they can form a puerperal miasma.

"It is also essential for the welfare of patients of a lying-in hospital that several rooms for isolation be provided so as to promptly separate infected from normal puerperæ."

It will be noted that this is exactly what Charles White insisted upon, what Kirkland approved of, and what Robert Collins practiced.

It was not until 1864 that Carl Braun of Vienna noted that ventilation was exceedingly important in lying-in hospitals. He is credited with the first effort to introduce the thorough scrubbing of hands with use of the nail brush, employing potassium permanganate as a disinfectant. Scanzoni, Semmelweis' bitter opponent, in his *Lehrbuch* published in 1867 says that puerperal fever is now generally considered to be an infectious disease characterized by the symptoms of pyemia or of sepsis.

Semmelweis proved with startling clearness and by means of incontrovertible evidence that the examining finger could and did convey infection to the puerperal woman. The comparatively clean practice of British hospitals from the time of Charles White was forced upon Semmelweis only when he learned that chlorine disinfection of the examining hand alone did not prevent puerperal fever. He did not enunciate the doctrine of wound infection or of wound fever; nor did he originate chlorine disinfection. At no period in his career did he even approach the low mortality of Robert Collins. His proof of the fatal rôle of the foul examining finger was an all-important

addition to the effect obtained by magnesium sulphate. Markedly hypertonic solutions of glucose in concentration as high as 50 per cent have been employed but should be used with care. On account of its more prolonged action, 20 to 25 per cent solutions of sucrose, such as are used by some neurological surgeons to reduce cerebral edema, should be of value. In most instances, prompt diuresis is produced, followed by marked lessening or disappearance of edema, often striking reduction in weight, lowered blood pressure, and general improvement. In many cases the improvement lasts long enough to enable the patient to carry on without progress of the disease until a living child can be delivered.

In some of these cases, in which the edema is lessened, there is a preliminary drop in blood pressure, followed in a few days or a week or so by a distinct rise, even though the edema does not reappear. When, in spite of treatment, the systolic blood pressure has remained more than 170 mm.; when it rises above this figure following treatment and temporary improvement; when examination of the ocular fundi reveals increasing arteriolar injury, fresh hemorrhages, retinal exudate, or retinal edema, or when examination of the blood gives evidence of acidosis, with the carbon dioxide combining power less than 30 volumes per cent, and more rarely increased retention of nonprotein nitrogen in the blood, it is evident that more active measures must be instituted.

Persistent and more or less severe headache, visual disturbances such as flashes before the eyes and dimness of vision, and epigastric pain, may be the first warning of serious illness aside from edema, to the patient or her associates. To the physician such signs are evidence of impending eclamptic convulsions. Associated with these symptoms there may be restlessness, sleeplessness, mental and muscular irritability, or, more rarely, marked drowsiness.

When preeclamptic toxemia is severe, or when eclamptic convulsions impend, one is faced with the responsibility of attempting to conserve the health and life of both mother and fetus. In many such cases actual convulsions may be averted by sedative, liver-sparing and diuretic measures. Even though these measures are taken, each day of prolongation of the disease in the presence of a blood pressure of more than 170 subjects the patient to the increased risk of chronic arterial or renal injury.

Termination of pregnancy is almost invariably followed by rapid drop in blood pressure, increased output of urine and general improvement in the patient's condition. The time in gestation at which pregnancy is terminated has a bearing on the percentage of fetal mortality; at thirty-four or more weeks there is a fair chance of the fetus being viable, the percentage rising with each additional week; between thirty and thirty-four weeks, the chance of extra-uterine survival is poor, and at less than twenty-eight weeks practically hopeless. One may be caught between the two horns of a dilemma, for temporizing in the hope of obtaining a living fetus may result in intra-uterine fetal death from the toxemia, in addition to increasing the maternal risk.

Although undue delay is dangerous, methods of forced delivery may be even more dangerous to both mother and child. Due to increased muscular irritability, induction of labor with castor oil is often successful, and usually is the first method to be tried unless the symptoms are most urgent. If this

fails, methods described elsewhere for induction of premature labor may be employed. In a multipara, rupture of the membranes is usually followed by onset of labor in twelve to twenty-four hours; to make this more certain, a No. 4 or No. 5 Voorhees bag may be inserted into the cervix and lower uterine segment. In a primigravida with adequate pelvic measurements, and considerable softening and some effacement of the cervix, a similar plan may be adopted. With the onset of labor care may be taken to avert convulsions which may be induced by the pain. For this purpose, in addition to the use of morphine, $\frac{1}{6}$ or $\frac{1}{4}$ grain (0.01 or 0.016 Gm.), with 2 cc. of 50 per cent magnesium sulphate given intramuscularly for its synergistic action, we have found the derivatives of barbituric acid most useful, particularly pentobarbital sodium which may be given by mouth in doses of 3 grains (0.2 Gm.) until 12 grains (0.77 Gm.) have been given; or intravenously in doses of 6 grains (0.4 Gm.). After pentobarbital sodium, 6 grains (0.4 Gm.), have been given intravenously, the patient falls into a sleep with the reflexes practically in abeyance; uterine contractions may be temporarily inhibited, but soon regain their force and regularity. Observation of labor in cases of normal pregnancy, and in toxic cases, seems to show that the use of certain derivatives of barbituric acid is accompanied by greater relaxation of the lower uterine segment, permitting acceleration of cervical dilatation. After labor starts, its progress must be closely observed, for delivery by forceps or version is sometimes indicated to shorten the second stage with its added strain. Readings of blood pressure during labor are useful, for continued high pressure or a rise of pressure indicate to the obstetrician when to interfere.

The occasion sometimes arises for careful manual dilatation of the effaced, partly dilated cervix, or for incision of the cervix in cases of slowly progressing labor. We have found useful the method of Dührssen, making one to three incisions of the completely effaced cervix in places which, with the patient supine, would correspond to 10, 2, and 6 on the clock dial. This seems to be safely accomplished when the cervix is rigid but completely effaced, and when it has ceased to dilate after reaching a dilatation of 4 or 5 cm. We have even practiced this procedure several times with 3 cm. of cervical dilatation. In each case the birth canal should be of sufficient proportions to permit of immediate extraction by forceps or version. The cervix is immediately repaired.

In recent years there has been a growing tendency to employ abdominal cesarean section in cases of severe preeclamptic toxemia. Cesarean section is probably indicated in the occasional case of severe preeclamptic toxemia affecting a primigravida at or near term, if the cervix is long, firm, and uneffaced, or if pelvic measurements arouse doubt as to the possibility of delivery by the birth canal. That this is not done without risk to both mother and fetus is indicated by the high maternal and fetal death rate after cesarean section. Following extensive inquiry in this country and abroad Plass published, in 1931, information concerning the relation of forceps and cesarean section to maternal and infant morbidity and mortality. He showed that general statistics revealed a maternal mortality of between 5 and 10 per cent following cesarean section; Holland, reviewing cases of cesarean section for eclampsia and other forms of toxemia in Great Britain and Ireland, found a maternal mortality of 30.3 per cent in 231 cases and a fetal mortality of 46.9 per cent, and Gordon, in Brooklyn, found a maternal mortality of 16.2

per cent and a fetal mortality of 21.9 per cent in a similar group of 210 cases. Plass stated: "It should moreover be stressed that abdominal delivery has little place in the treatment of eclampsia and that conservative medical care has actually established itself as a treatment of choice."

ECLAMPSIA

Eclampsia is a convulsive disease peculiar to the later months of pregnancy, usually characterized by high blood pressure, marked albuminuria, and edema. It is associated with progressive symptoms of headache, dizziness, disturbances of vision, epigastric pain, tonic and clonic convulsions, and sometimes coma and death.

Eclampsia is not a new disease, for convulsive attacks during pregnancy were described by ancient writers. There is no similar disease in animals. Paresis in cattle, which was thought to resemble eclampsia, always occurs postpartum and is associated with weakness and paralysis rather than convulsions. The paresis seems to be in some way connected with the onset of lactation; strangely, in some instances, injection of air into the udders relieves the condition.

Incidence.—The incidence of eclampsia varies in different localities and different countries. It is more common in cold than in tropical countries, although it occurs in southern states of the United States as frequently as in northern states. Hinselmann stated that the incidence of eclampsia is lower in Germany than in England; Germany, with a population of 60,000,000 has 2484 cases yearly, whereas England, with a population of 40,000,000, has 2800 cases yearly. Dublin has a lower incidence than London, and Glasgow a higher incidence than London. Various observers have felt that seasons or the weather influence the frequency of occurrence. Davis and Harrar noted a greater number in the New York Lying-In Hospital in April, Zinsser found more in the spring or autumn, associated with sudden change in the weather or drop in temperature; Hinselmann, Seitz, and others noted a lessened incidence of eclampsia in Germany during the World War. This was said to be due to the restriction of protein and fat in the diet as a result of the blockage against foodstuffs.

Hinselmann stated that eclampsia occurred once in sixty-eight deliveries of primigravidas and once in 4000 deliveries in multigravidas. Griefenstein reported 212 cases of eclampsia in 20,000 deliveries in Bonn, an incidence of one case of eclampsia in ninety-eight deliveries. The frequency of recurrence of eclamptic attacks is not great. Laun, in 1928, reviewed the literature and stated that the percentage of recurrence of eclampsia is between 1.5 and 8 per cent. Schmechel reported 238 cases of eclampsia in 27,430 deliveries, or one in every 115 deliveries. Eighty-three of the 238 patients experienced subsequent pregnancies, thirty-three or 40 per cent of whom had eclamptic symptoms, and fifteen or 18 per cent had eclampsia. Schmechel quoted Zangemeister as reporting recurrence in 12 per cent of 40 cases. Griefenstein noted that of 78 patients with eclampsia who subsequently became pregnant, two had recurrence of eclampsia, an incidence of 2.6 per cent.

Causes.—Obstetrical literature is replete with hypotheses of the cause of preeclamptic toxemia and eclampsia but no generally accepted one has been produced. Certain clinical and pathologic observations must be satis-

by a male physician. In his *Eulogium on Dr. Shippen*, Caspar Wistar gives a very clear picture of the prejudice with which male practitioners of midwifery were confronted:

> "It was only when something very important was to be done, that they (male practitioners) were resorted to—and, very often, when too late. This was altogether the effect of prejudice, and not of necessity, for several of the medical gentlemen were accoucheurs—and our late worthy president, Doctor Redman, had been declared, by Doctor Bond, to be the best obstetrical practitioner he had ever known—yet, he attended very few natural labours. By Shippen this prejudice was so done away, that in the course of ten years he became very fully employed. He also taught midwifery. Prior to the revolution, he seems to have had a distinct class of students in this branch: . . ."

On September 17, 1765, William Shippen, Jr. was chosen professor of anatomy and surgery in the College of Philadelphia. He continued his lectures on anatomy, which were uninterrupted until the winter of 1775–1776, when they were suspended because of the Revolution. In 1777 he succeeded John Morgan[1] (1735–1789) as Director-General of the Medical Department of the Army. Charges were preferred against him for his conduct while in office, but he was acquitted by court-martial in 1780 and reappointed Director two months later. He resigned in 1781.

Shippen is described as a brilliant lecturer, a man of polished manners and remarkable judgment in selecting what was pertinent in elucidating a principle. John W. Francis in the preface to his edition of Denman's *An Introduction to the Practice of Midwifery* says:[2]

> "The late Dr. William Shippen of Philadelphia, has the honour of having been the first public teacher of midwifery in the United States. While in Europe, he enjoyed the high advantage of the direct instruction of Dr. William Hunter, and on his return to his native country, was chosen professor of anatomy in the medical school of Pennsylvania. His lectures on obstetrics, like his course of instruction on anatomy and surgery, evinced profound knowledge of his subject, consummate ability, and unrivalled command over his auditory. Dr. Shippen's first course of midwifery was delivered in 1762."[3]

The efforts of Shippen bore fruit in that the private midwifery course which he inaugurated was continued long after the establishment of the chair of midwifery in the medical department of the University of Pennsylvania. For many years following the appointment of a professor of midwifery, the course was not required for graduation,[4] and many students preferred to take the extramural course without attendance upon the lectures of the regularly constituted professor in the university. Extramural instruction in anatomy was continued for many years and followed in conception the

[1] John Morgan was appointed Director-General of the Medical Corps in October, 1775, succeeding Benjamin Church (1734–1776) who had been dishonorably discharged for treason. Morgan set himself to bring order out of chaos, but largely due to the jealousy and insubordination of his regimental officers he was dismissed from the post in October, 1776. Morgan was one of the most distinguished of the early American physicians and the principal founder of what was to become the medical department of the University of Pennsylvania. His essay on medical education is a classic.

[2] New York, 1821.

[3] As noted previously, this date is probably erroneous.

[4] Thomas G. Morton and Frank Woodbury (loc. cit.) note that: "It was not, however, until 1843 that the Trustees of the University fully recognized the standing of this department of teaching by making attendance upon the lectures on midwifery obligatory upon the students, who expected to obtain the medical degree."

John Bard had received as good an apprentice training as the early colonies afforded. At an early age he was apprenticed to John Kearsley[1] (1685–1772) of Philadelphia with whom he spent seven years. He began practice in Philadelphia and soon married a niece of Mrs. Kearsley. After a few years of practice in Philadelphia, he was persuaded by Benjamin Franklin to remove to New York City because of the recent depletion of the ranks of the medical profession there by yellow fever. He became acquainted with Peter Middleton[2] (d. 1781) who was the acknowledged leader of the profession in New York and assisted Middleton in one of the earliest anatomical dissections (about 1750) in which the blood vessels were injected and the dissected cadaver preserved for the instruction of medical apprentices. Bard was one of the most distinguished of the early physicians.

Another interesting case of extra-uterine pregnancy occurred in the practice of **William Baynham** (1749–1814), a son of Dr. John Baynham of Caroline County, Virginia. Baynham went to London in 1769 where he spent sixteen years in the study and practice of anatomy and surgery, ultimately serving as assistant to Mr. Joseph Else[3] (d. 1780), surgeon to St. Thomas's Hospital. On the death of Mr. Else (1780), Baynham was an unsuccessful applicant for the vacancy thus created, the post going to Henry Cline[4] (1750–1827). In spite of his London success, which was notable, Baynham returned to Virginia in 1785 and settled in Essex County, where he practiced until his death. He was without doubt the best trained surgeon and obstetrician in any of the states of the newborn American union and was ranked as a worthy contemporary of Philip Syng Physick[5] (1768–1837). Unfortunately, Baynham was not connected with a teaching faculty in a center of medical education. Had he been so associated it is probable that he would have acquired by virtue of his training and ability preeminent rank in American surgery.

Baynham's report on extra-uterine pregnancy appeared in 1809 in the *New York Medical and Philosophical Journal and Review* (vol. i) and was one of the earliest accounts of this condition. His first case was that of a woman who consulted him in 1786 with the history that several years before she had been pregnant and at full term; that labor supervened but without effect and after a few hours she became conscious that the child was dead. No interference was attempted. For approximately a year subsequent to this

[1] John Kearsley came to Philadelphia from England about 1711. He took a prominent part in public affairs, established a large medical practice and as a result of his design for Christ Church in Philadelphia acquired some reputation as an architect.

[2] Peter Middleton studied at St. Andrews University. After coming to New York he assisted in the organization of the medical faculty of King's College and served as professor of pathology and physiology from 1767 to 1770; of chemistry and materia medica from 1770–1776; and was a governor of the college, 1770–1780.

[3] Joseph Else was elected a fellow of the Royal Society in 1778; was surgeon to St. Thomas's Hospital, and a member of the Royal Academy of Surgery of Paris. Many of his essays were collected after his death and published by George Vaux in 1728. In this collection his essay on the cure of hydrocele is of special interest.

[4] Henry Cline began practice in London in 1774; lectured on anatomy at St. Thomas's Hospital, 1781–1811, and was surgeon from 1784–1811.

[5] Philip Syng Physick, "Father of American Surgery," served one year as house-surgeon at Guy's Hospital, and before leaving London was elected to the Royal College of Surgeons. He was professor of surgery at the University of Pennsylvania, 1805–1819; professor of anatomy, 1819–1831; and emeritus professor of anatomy and surgery, 1831–1837. He was one of the first in America to use the stomach tube and his inventions in orthopedic surgery brought him wide fame.

mole cannot be explained by the hypotheses which depend on the idea either of interagglutination or of anaphylaxis.

Placental autolysis has been offered by Young as the cause of eclampsia. He has expressed the belief that infarct of the placenta results in placental degeneration, and that poisons from destroyed placental cells enter the maternal circulation and produce autolysis of the liver and other cells, these broken-down cells producing toxemia of pregnancy. According to his theory all cases of eclampsia are caused by placental infarction, even though changes in the placenta may be too slight to be observed through the microscope. Gessner and others have called attention to the frequent occurrence of placental infarcts in cases in which chronic nephritis occurs and have noted that this condition is seldom associated with true eclampsia. Gessner also has called attention to the similarity of the placenta of woman to that of many animals and has pointed out that eclampsia does not occur in animals. Numerous studies and experiments have been made on the functions of the placenta, its circulation, and its secretion, but no undisputed hypothesis concerning its relationship to eclampsia has been evolved. FitzGibbon has stated that laboratory demonstrations of the presence of a toxin in the placenta of animals and in other tissues have invariably been proved to be fallacious.

Several of the most outstanding hypotheses that eclampsia is due to physiologic chemical changes in the body are as follows:

Zangemeister in 1903 reiterated the opinion which was suggested by Traube and Rosenstein, in 1864, that eclamptic convulsions are due to cerebral anemia caused by edema which affects the brain as well as other bodily tissues. Wieloch has agreed with Zangemeister that some process causes the smaller blood vessels to become permeable to fluid, allowing edema to develop. Harding and Van Wyck have revived the hypothesis that excessive intake of sodium chloride is a potent factor in the development of toxemia of the later months of pregnancy. They have expressed the opinion that accumulation of sodium chloride may or may not be preceded or accompanied by retention of water. Hofbauer found that acute histamine poisoning of carnivora produces changes in the liver and kidneys resembling those of eclampsia. He suggested that the lesions of eclampsia might be produced by absorption of similar products from broken-down cells of placental ectoderm. Dieckman produced partial thrombosis and central necrosis of the liver by injection into the portal vein of tissue fibrinogen, accompanied by injection of the same substance into the peripheral circulation. He deduced that the lesions of eclampsia could be produced by the thrombotic action of substances entering the portal circulation from the intestine. Under normal conditions he said, these substances are neutralized or broken up in the portal vein by proteolytic enzymes which, during pregnancy, are not so readily available, for they are used up to take care of placental elements constantly entering the general circulation. He quoted Mills to the effect that the clotting time of the blood is shortened by ingestion of proteins, and he conjectured that this explains why limiting intake of protein in the last months of pregnancy, and good intestinal elimination, have been so effective in reducing the incidence of eclampsia.

Following several years' study of serial determinations of blood sugar in eclampsia, Titus and his co-workers suggested the hypothesis that hypo-

the age of seventeen years and suffered a very unpleasant experience with the midwives who at one time declared her pregnant and in labor. After fourteen days a physician was sent for and "under God's blessing soon restored me." The physician ascertained that she was not pregnant but had suffered some minor malposition of the uterus. Because of this unfortunate experience she studied midwifery and was soon called in consultation by local midwives who regarded her highly. Her reputation increased with the result that she was appointed court midwife. In the course of her practice she took copious case notes in order that she might profit by her clinical experience. Finally, as a result of the urgent entreaties of many of her friends, including the Queen of England—probably Sophia Dorothea (1666–1726), first wife of George I (1660–1727)—she published at her own expense a volume on mid-

Fig. 44.—Facsimile of the engraved title page of *Die Chur-Brandenburgische Hoff-Wehe-Mutter* by Justine Siegemundin, Cölln. a. d. Spree, 1690.

wifery generously illustrated with copper plate engravings[1] (Fig. 44). The major portion of the volume consists of a dialogue between Justine and a pupil, Christina, and is divided into two parts: the first consisting of didactic instruction—the question and answer method—and the second a review, with a reversal of the method, the instructor propounding the questions.

[1] *Die Chur-Brandenburgische Hoff-Wehe-Mutter, das ist: Ein höchstnöthiger Unterricht, von schweren und unrechtstehenden Geburten, in einem Gespräch vorgestellet, wie nehmlich, durch Göttlichen Beystand eine wohl-unterrichtete und geübte Wehe-Mutter, mit Verstand und geschickter Hand, dergleichen verhüten, oder wanns Noth ist, das Kind wenden Könne, durch vieler Jahre Ubung, selbst erfahren und wahr befunden, nun aber, Gott zu Ehren un dem Nechsten zu Nutz, auch, auf gnädigst- und inständiges Verlangen, Durchlauchtigst- und vieler hohen Standes-Personen nebst Vorrede, Kupfer-Bildern, und nöthigem Register auf eigene Unkosten zum Druck befördert.* Cölln. a. d. Spree, 1690.

may develop or other untoward reactions may appear. Muscular irritability and twitching may follow too great loss of chlorides from the tissue. Beneficial effect has been noted, and no harmful results have followed the use of 2000 to 3000 cc. of 10 per cent glucose in 0.6 per cent saline solution daily over a period of several days. If sugar appears in the urine the use of solution of glucose is temporarily discontinued, but no untoward effects have been noted from temporary hyperglycemia, for the excess promptly is excreted in the urine. Of course, before dextrose is used the possibility of diabetic coma should be ruled out by examination of the blood and urine made as an emergency. We have used insulin in doses of 10 units directly after, or with, injection of 100 Gm. of dextrose. The effect apparently has not been more favorable than when dextrose has been used alone, but this may be due to the relatively small doses used as compared with those used by Stander[121] and Miller.

Magnesium sulphate in doses of 10 cc. of a 25 per cent solution may be given intramuscularly, or 20 cc. of 10 per cent solution intravenously. None should be used if the carbon dioxide combining power of the blood is less than 20 volumes per cent, or if the patient is in coma. On our maternity service magnesium sulphate has been given by both of the routes mentioned, but in the last few years its use intravenously has been discontinued, and when given intramuscularly it is always as an adjunct to intravenous administration of dextrose. Reports indicate that solution of magnesium sulphate is of distinct value in preeclamptic toxemia and in eclampsia, when dextrose is not used or is not available. However, dextrose usually will relieve acidosis, and Mann and his co-workers have shown its value as a sparer of the liver, neither of which effects may be attributed to magnesium sulphate.

During convulsions the patient's tongue is protected from laceration by a padded mouth gag. The room is quiet, and darkened, and a nurse is in constant attendance. Cyanosis, especially if marked, is combated by inhalation of 5 per cent carbon dioxide in oxygen. This is also indicated in pulmonary edema. If dextrose given intravenously fails to control acidosis solution of sodium bicarbonate, 5 per cent, as advised by Wilson, may be used. If sedative substances fail to control convulsions, ether given by inhalation or by colon, or ethylene and oxygen given by inhalation may prove of temporary value. Anesthesia by nitrous oxide and oxygen raises blood pressure and is contraindicated, as is chloroform on account of the hepatic injury it may produce. Stander[121] has warned against the use of any anesthetic by inhalation in severe preeclamptic toxemia or eclampsia.

When the convulsions have been controlled, subsequent treatment depends on several conditions. With the cessation of convulsions there may be improvement in other symptoms, and convulsions may not recur. Under such favorable conditions, if the fetus is living, and is below the period of viability, the patient may be carried along sometimes even to term. Following this primary improvement, convulsions may recur hours or days later. Warning of this is usually given by rise in blood pressure, more marked changes in the ocular fundi, persistence or even increase of albuminuria, and development of acidosis.

When such symptoms indicate impending recurrence of convulsions, or during a remission in severe cases or in less severe cases when symptoms are becoming less favorable, many obstetricians following modified conservative

lated (Philadelphia, 1831) Alfred-Armand-Louis-Marie Velpeau's[1] (1795–1867) *Elementary Treatise on Midwifery.* Meigs also called particular attention to sudden death post partum, attributing this untoward circumstance to the formation of a thrombus in the right auricle.

Wherever the powerful influence of Jefferson Medical School and the Medical Faculty of the University of Pennsylvania was felt the teachings of Meigs and Hodge dominated. Neither can be said to have added much to the science of midwifery, although Hodge's contributions to a clearer understanding of the parturient canal constituted a real advance.

Formal instruction in midwifery in New York began in 1767 with the organization of a faculty of medicine under the auspices of King's College, and **John Van Brugh Tennent** (1737–1770) was appointed professor of obstetrics. His associates in the newly organized faculty were Samuel Clossy,[2] professor of anatomy; John Jones[3] (1729–1791), surgery; Peter Middleton, physiology and anatomy; James Smith,[4] chemistry and materia medica; and Samuel Bard, the practice of physic. Tennent was born in Bucks County, Pennsylvania, and after graduating from the College of New Jersey (Princeton), pursued his medical studies in Edinburgh where he was graduated in 1764. Tennent no doubt pursued the study of midwifery in London because at that time only slight attention was given to the teaching of clinical midwifery in Edinburgh. At any rate he must have spent considerable time in study in London for before he left England he was made a member of the Royal Society. Shortly after the organization of the medical faculty of King's College, Tennent developed signs of pulmonary tuberculosis and went to the West Indies, where his death occurred in 1770 following an attack of yellow fever.

The second professor of midwifery in King's College, **Samuel Bard** (1742–1821) (Fig. 68), was appointed in 1770. He was born in Philadelphia April 1, 1742, the son of Dr. John Bard. His mother was a niece of Dr. John Kearsley of Philadelphia, who had functioned as the medical preceptor of his father. Bard's preliminary education was secured in a private grammar school and at the age of fourteen he entered King's College, at the same time giving some attention to medical studies under the direction of his father. In the autumn of 1760 he sailed for Europe and reached London in the early summer of 1761, subsequent to a six months' imprisonment at the hands of the French, the vessel on which he left America having been captured by a French privateer.

[1] Alfred-Armand-Louis-Marie Velpeau succeeded Alexis Boyer (1757–1833) as professor of surgery at the Charité, but he devoted himself to midwifery as well as surgery.

[2] Samuel Clossy was born in Ireland and graduated from Dublin University. Before coming to America he had published in 1853 *Observations on some of the Diseases of the parts of the human body.* He returned to Ireland at the outbreak of the Revolution.

[3] John Jones was born in Jamaica, Long Island. After serving his medical apprenticeship under Thomas Cadwalader he went to London where he studied under William Hunter, Colin Mackenzie and Percivall Pott (1714–1788). He later journeyed to France where he paid particular attention to anatomy and surgery. He received his M. D. from Rheims. After spending some time at Leyden and Edinburgh he returned to New York to begin practice as a surgeon. Thacher says he performed the first lithotomy in New York City. His *Plain, Concise and Practical Remarks on the Treatment of Wounds and Fractures* was used by surgeons in the Revolution and he was active in the organization of the medical department of the army. He moved to Philadelphia in 1780 where he was appointed surgeon to the Pennsylvania Hospital. He was one of the founders of the College of Physicians of Philadelphia.

[4] James Smith received his M. D. from Leyden.

fetus. Unless disproportion, or, rarely a firm, undilated cervix indicates the advisability of cesarean section, the patient is given pentobarbital sodium or sodium iso-amylethyl barbiturate (sodium amytal), 6 or 9 grains (0.4 or 0.6 Gm.) intravenously. In the limited number of cases in which we have observed the effects of these drugs, there has been cessation of convulsions. Evidence of acidosis should be treated as previously described. Intrapartum eclampsia is shortened by delivery, and ordinarily no further convulsions occur after birth of the child. Blood pressure is decidedly reduced and output of urine is increased. Maternal and fetal mortality are less than in prepartum eclampsia.

The occurrence of postpartum eclampsia is one of the strongest arguments against radical measures, for it proves that emptying the uterus may not stop or prevent convulsions. Any case of severe preeclamptic toxemia is a potential case of eclampsia for twenty-four to forty-eight hours after delivery, and sedative and other measures are continued for several days. Almost as a routine in cases of hypertension, morphine, $\frac{1}{6}$ to $\frac{1}{4}$ grain (0.01 to 0.016 Gm.), in 2 cc. of 25 per cent solution of magnesium sulphate is given intramuscularly soon after labor.

Although most patients with eclampsia improve immediately after delivery, care must be taken in diet, elimination, and avoidance of factors irritating to the nervous system. The diet low in protein is continued while the patient is in the hospital, salt is added to the food when edema has disappeared, and fluid is usually given freely. The output of urine is measured, for occasionally there is partial or complete suppression of urine after the convulsions have ceased. In such cases, fluids should be given guardedly, for the anuria may be due to such acute congestion of the kidney that the glomeruli cannot function. In such rare instances the operation of renal decapsulation advised by Harrison and Edebohls may be indicated. The blood of the patient who has eclampsia should be examined after delivery, for there may be an unsuspected increase in retention of nonprotein nitrogen.

Readings of blood pressure and output of urine are recorded daily. As a general rule the patient should be kept in bed until the systolic blood pressure has dropped to less than 140 mm. or until the albuminuria is reduced to grade 2, if possible. When the blood pressure is not practically normal within two weeks, and when albumin graded 2 is found in the urine after two weeks, the development of chronic nephritis is suspected. There should be a follow-up plan of reexamination of these patients for at least a year postpartum, such as that in operation at the Boston Lying-in Hospital, as described by Berman. Such careful observation will enable the physician to diagnose many cases of more or less severe chronic nephritis which have been "lighted up" during pregnancy, or which have developed subsequent to preeclamptic toxemia or eclampsia.

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in the *Transactions of the Ohio State Medical Society* for 1854 a careful reading and hence concluded that Wright's method did not involve the use of both hands. Hicks subsequently restated his position and gave Wright full credit for bimanual cephalic version although stating correctly that he (Hicks) carried the procedure much further by causing the head to engage through pressure on the breech and applying the method as well to podalic version. Hicks says:

"By its means one can make a complete podalic presentation out of a cephalic, with only one or two fingers in the os uteri, and this with a precision and security which leaves little more to be desired. I think I am not exceeding my rights, when I claim that till I first described the plan in 1860, no one else had done so."

In the *American Journal of Obstetrics* (vol. xii) for 1879, Dr. Hicks published a communication entitled *On Combined External and Internal Version of the Fetus in Utero* in which he says:

"I have already . . . made some remarks . . . , for the purpose of admitting, firstly that, so far as the case of cephalic version was concerned, Dr. Wright had the right of priority in the recommendation of the use of the external hand to press the breech of the fetus to the fundus uteri; or, in his own words, 'to dislodge the breech,' 'to loosen the contact and perhaps diminish the force of adhesion'; and secondly, with the view of claiming a place for myself as an independent discoverer of this method of cephalic version, and also the priority of a much greater advance, namely, complete as well as partial cephalic version, by the use of the hand outside and inside the womb."

It seems perfectly clear that Wright is entitled to priority in devising a method of bimanually converting a shoulder into a cephalic presentation, and America obstetricians have claimed for Wright's description all that Braxton Hicks chose to attribute to his method of bimanual version, published nearly ten years later. Subsequently Richard A. F. Penrose (1827–1908) of Philadelphia described cephalic version in shoulder presentations in 1855[1] with apparently no knowledge of Wright's earlier publication. Penrose was professor of midwifery and diseases of women and children in the University of Pennsylvania from 1863 to 1889 and is described as a brilliant teacher whose chief reliance was upon manikin demonstrations.

American physicians played a stellar rôle in the development of the science of gynecology and our very familiarity with the names of Ephraim McDowell, J. Marion Sims, Robert Battey, Nathan Bozeman (1825–1905) and many others attests the importance of their contributions. To catalogue the advances made by American physicians and surgeons in this field would prove a well-nigh impossible task. Mention, however, must be made of a few of the "landmarks" that have illumined the pathway to modern procedures.

In the year 1809, Danville, Kentucky,[2] was a "far-cry" from the centers of medical learning and yet in that year there was performed in Danville, for the first time, an epoch-making surgical operation unrivalled in boldness. Ephraim McDowell (1771–1830) (Fig. 72), the surgeon, was thirty-eight years of age and the leading surgeon and physician west of the Alleghenies. His medical training was that of the Edinburgh school, where his preceptor, Dr. Humphreys of Staunton, Virginia, had graduated and where in 1793–1794

[1] *Medical Examiner*, July, 1855.
[2] In 1809 Mercer County, now Boyle County.

1825), who became professor of midwifery at Göttingen, advocated the extensive use of the midwifery forceps: of 2540 cases of labor 1016 were terminated by means of the forceps. Osiander's teaching may be traced directly to the influence of Levret, although Levret's use of forceps did not begin to approach that of Osiander. Wilhelm Joseph Schmitt (1760-1827) of Lorch on the Rhine, adopted the conservative teaching of Boër as contrasted with that of Osiander. Boër's influence spread to Leipzig and Prague where his pupils taught his principles and made further advances in both midwifery and gynecology. Adam Elias von Siebold (1775-1828), professor in Berlin, was the distinguished author of the classical history of midwifery. His son, Ed. Carl Caspar von Siebold (1801-1861), was professor of midwifery at Göttingen. The two Nägeles—Franz Carl (1777-1851) and Hermann Fr. J. (d. 1851)—contributed much to our knowledge of deformities of the pelvis.

Early in the nineteenth century the number of contributions from Germany on the subjects of midwifery and diseases of women notably increased. Among those who contributed largely to the development of midwifery and gynecology based upon a growing knowledge of physiology and pathology may be mentioned Eduard Arnold Martin (1809-1875) of Berlin, Anselm Martin (1809-1883) of Munich, Bernhard Seyfert (1817-1870) of Prague, Karl Schroder (1838-1887) of Berlin, Carl Hecker (1826-1882) of Munich, Robert Olshausen (d. 1894) of Halle, Otto Spiegelberg (1830-1881) of Breslau, Alfred Hegar (b. 1830) of Freiburg—who, as Bass says, performed the first extirpation of normal ovaries (Battey's operation) in 1872—A. Gusserow (b. 1836) of Berlin, and Hermann Beigel (1830-1879) of Vienna.

With the approach of the middle of the nineteenth century, we find German surgeons devoting considerable attention to the pathology of the female pelvis. Rudolph Virchow's (b. 1821) *Archiv* was founded in 1847 and his *Cellular-pathologie* appeared in 1858. A new physiology was in the process of development and Carl Ludwig (1816-1895) was soon to establish his great school with its world-wide influence. Chemistry as applied to the living body, under the leadership of Justus von Liebig (1803-1873), had broken from its inorganic fetters, and with the synthesis of urea at the hands of Friedrich Wohler (1800-1882), a flood of light had illuminated the chemistry of the living organism. Pathologic processes had acquired new meanings and intensive studies of the pathology of the female pelvis naturally followed.

By the middle of the nineteenth century the attention of the medical world was focused upon new discoveries in pathology and physiology emanating from Germany, and with the advent of the science of bacteriology, German contributions, particularly to the etiology of disease, established a high-water mark of scientific advance. German midwifery and gynecology reflected these advances and from 1870 onward the medical world has been under heavy tribute to German investigators in this field. Most of the progress made in Germany was promptly recorded in journals dealing with diseases of the female pelvis, for example, the *Archiv für Gynækologie* (founded in 1870), the *Zeitschrift für Geburtshülfe und Gynækologie* (founded in 1877), and the *Zentralblatt für Gynækologie* (founded in 1877).

be continued, in the belief that, under careful prenatal supervision, complications could be safely met, if they arose. At a later date the patient came under the author's care.

A few weeks previous to her estimated date of confinement it was discovered that she had a breech presentation; and an x-ray taken about two weeks before her expected time of delivery indicated that she had a large child. The patient was warned to report immediately if labor began, or if any unusual incident occurred. In the middle of the night the author was notified that the amniotic sac had ruptured. The patient was immediately removed to the hospital and on rectal examination it was discovered that she had a rigid os and that she was not in labor. Realizing the patient's age and the complications that might arise if she were permitted to be delivered from below, and inasmuch as no vaginal examination had been made, a cesarean section was performed and a large child was recovered from the right half of a uterus didelphys. The child lived.

The mother made a good recovery, although her convalescence was prolonged because a large sponge was left in the uterus and was not recovered for four weeks following the operation. The uterine wall, in this case, was extremely thin and there was an unusual amount of hemorrhage. Two sponges were purposely left in the uterus to control hemorrhage, one of which, unfortunately, was not recovered at the usual time, although it was thought that both had been removed twenty-four hours after the section had been performed. A uterosalpingography, which was made after convalescence, demonstrated a typical case of almost symmetrical uterus didelphys (Fig. 503).

Summary.—Congenital anomalies of the female genital tract occur in about 1 per cent of pregnancies and are the cause of serious complications in pregnancy and labor.

In these selected cases the anomalies did not appear to have any deterrent effect on conception.

Anomalies are the cause of abortion, miscarriage, premature delivery, and, in rare instances, uterine rupture.

Congenital anomalies are more frequent than is generally recognized; and the obstetrician should be on the alert to recognize them, particularly, in cases where repeated abortions and miscarriages occur without demonstrable cause.

Diagnosis by uterosalpingography can be made with practically no danger and should be a routine procedure in all cases in which an anomaly is suspected.

While complications of various kinds are common, many women go through pregnancy and labor without incident.

The possibilities of metroplasty in women in whom repeated abortions and miscarriages occur, should stimulate the practitioner to attempt relief by surgical means.

TUMORS

Some serious complications of pregnancy may be caused by tumors of the female genital tract; they may appear in any part of the genitalia; and they cause trouble because of their tendency to produce abortion, miscarriage, premature labor, obstruction of the passages, and postpartum hemorrhage. They may be either malignant or benign.

The benign tumors, which, fortunately, are much more common than the malignant, may produce complications which require the highest degree of obstetrical judgment in order to conserve the best interest of both mother and child.

As prenatal care becomes more common these lesions should be recognized earlier in pregnancy.

Fibroids.—The most common pelvic tumor which is found in pregnancy is the uterine fibroid. These tumors are usually contemporaneous with the child-bearing period and they are so common that the obstetrician is on the lookout for them. Some observers state that 40 per cent of all women have fibroids. Litzenberg believes that cases of fibroid associated with pregnancy, with or without complications, approximate 50 per cent. Graves states that uterine myomata occur with extraordinary frequency.

Notwithstanding their frequency, small uterine fibroids do not usually interfere with fertility, with the continuation of pregnancy, or with labor.

Curtis succinctly states: "With fibroids pregnancy may not occur; the most frequent disturbances, however, are interference with development of, and delivery of the fetus, rather than the prevention of conception." This author believes that uterine fibroids are less important in the prevention of conception than in producing sterility after conception has occurred, due to interference with the development of the fetus. However, all are agreed that these tumors do interfere somewhat with nidation by disturbing the structure and the circulation of the endometrium.

Polak, in a detailed and excellent article on this subject, stated that, in his series, 21 per cent of pregnancies with fibroid uteri terminated in abortion or premature labor, and he believed that obstetrical complications are from four to six times more common in uterine myoma than in the average case; he felt that the usual statement that fibroids associated with pregnancy are more or less harmless, should be corrected.

Kosmak and others state that fibroids produce irregular bleeding and sepsis during pregnancy and after labor.

From a review of the literature, and from the author's own observation, it is evident that there are two extreme views concerning the gravity and significance of uterine fibroids complicating pregnancy; some authors regard this association with a great deal of apprehension, while others feel that the harmful effects are almost negligible. The author does not believe that either extreme is correct but assumes a somewhat middle ground on the subject. He would, however, urge most painstaking prenatal observation and most careful attention during labor and immediately following it, in all cases where the fibroids are of clinical importance.

The importance of the bearing of fibroids on pregnancy and labor depends upon both the size and location of the tumors in the uterus. Most subserous growths, unless large and lying low in the pelvis, may be disregarded, while the interstitial form and the submucous forms have a tendency to produce hemorrhage and induce abortion.

Careful prenatal observation is the keynote of the management of uterine fibroids complicating pregnancy. In every instance the obstetrician must appreciate the possibility of abortion, miscarriage, premature delivery, difficult labor, postpartum hemorrhage, and puerperal complications. Notwithstanding these possibilities all obstetricians of experience have observed

Emmet always regretted the interruption which came to Sims' career incident to the Civil War and his years of residence in Europe. While honor thereby accrued to American gynecology, yet, as Emmet says:

"Sims never advanced beyond the work which he described in the remarkable paper delivered before the New York Academy of Medicine previous to his departure."

Relative to his own contributions, Emmet says:

Fig. 75.—Thomas Addis Emmet. From *The Birthday Dinner to Thomas Addis Emmet, M. D., LL. D., given by his Professional Friends at Delmonico's, New York, May 29, 1905.* New York, 1905.

"Much good was accomplished by demonstrating the existence of lacerated cervix and the close relation of the injury to epithelioma, if it be not the actual cause. The operation for repair filled an important place, but a still greater advance was made on showing the greater necessity for amputation, when it was discovered by me that in many cases the character of the lesion had become changed owing to the use of aseptic midwifery. Yet, it is difficult to determine if the good which has been obtained under all favorable circumstances counterbalances the evil from the great abuse which has existed from operating unnecessarily, as well as from neglect on the other hand where an operative procedure should have been employed. The discovery of this injury and operation gave me a world-wide reputation, and yet I have never been satisfied. From some unexplainable cause the profession at large has never mastered the subject in detail sufficiently to enable the good derived to compensate for the amount of injury resulting from ignorance or want of dexterity."

From a perusal of a number of personal letters from Emmet,[1] it is clear that

[1] In library of Northwestern University Medical School.

Adenocarcinoma of the uterus usually occurs after the climacteric but there are a few cases in which it accompanies pregnancy. Some authorities have considered pregnancy a cause of adenocarcinoma of the uterus, but Cullen reports 19 cases in which 52 per cent had never been pregnant. Sarwey, quoted by Schumann, states that it is unthinkable that carcinoma of the fundus can coexist with pregnancy and states that the development of the ovum in the uterine cavity, the seat of carcinomatous degeneration, is impossible.

Schumann reviewed the literature concerning the coexistence of carcinoma of the fundus uteri in pregnancy and reports a case of a woman, age forty-three years, para 10, in whom a provisional diagnosis of carcinoma of the fundus was made. The patient was lightly curetted and a pathologic diagnosis of adenocarcinoma was made. A panhysterectomy was performed and the uterus was found to contain a two and a half months' embryo with an unruptured sac.

The writer has observed a few cases of adenocarcinoma in women of child-bearing age, but has never observed pregnancy with this complication. However, he can see no reason why nidation should not occur in the presence of this lesion.

Carcinoma of the vagina and carcinoma of the vulva are rare complications of pregnancy. In the presence of these neoplasms every effort should be made to conserve the life of the fetus.

Summary.—Of all tumors of the female genitalia which complicate pregnancy, uterine fibroids constitute by far the greatest number.

Uterine fibroids of clinical importance may produce abortion, miscarriage, premature labor, obstruction of labor, and postpartum hemorrhage, and surgical intervention may be required.

Ovarian tumors of benign character present essentially the same mechanical problems during pregnancy as do uterine fibroids.

Benign genital neoplasms, in the majority of cases, do not produce serious complications in pregnancy, although they require painstaking prenatal observation by the obstetrician during the entire period of gestation.

Malignant tumors of the female genitalia complicating pregnancy are of extreme maternal gravity. The fetal mortality is high.

INFECTIONS

When the obstetrician considers the part infection plays in the production of infertility, and adds to that the disturbances that are produced during pregnancy and the puerperium by the infectious organisms which invade the genital tract, he must realize the calamitous rôle which infection plays in the life of the woman who desires to bear children.

A few years ago the author reviewed statistics in an attempt to ascertain what percentage of female sterility is due to tubal obstruction of infectious origin. These statistics, while somewhat conflicting, indicate that tubal disease alone causes about 50 per cent of all female sterility. Funck-Brentano states that gonorrhea is the great white plague that keeps up insidiously the extermination of the human race. Norris says that gonorrhea is the most potent factor in the production of race suicide, and, through sterilization and abortion, does more to depopulate the country than any other cause. Polak wrote that when a man once has a chronic posterior urethritis he is never

cured of his infection and under the excitation of coitus he may infect the cervix. The author is impelled to remind the obstetrician that 20 per cent of all blindness of the world is due to gonorrhea and that "in passage through the infected maternal parts the child undergoes a veritable baptism of virulence" (Morrow).

The usual pathologic organisms found in the female genitalia during pregnancy are well recognized. The gonococcus, the Bacillus coli communis, the streptococcus, the staphylococcus, and the tubercle bacillus are mentioned in the probable order of their importance. Louise McIlroy states that the most common infection during pregnancy is with Bacillus coli and she warns the obstetrician not to ignore urinary symptoms during pregnancy.

In addition to the above-named organisms, there are others which are associated with the contagious diseases, such as diphtheria and measles and, particularly, those due to the streptococcus, such as scarlet fever, erysipelas, and septic sore throat.

Recently the writer saw in consultation a woman who died from puerperal infection five days after the birth of her child. There is every reason to believe that this infection had its origin in a streptococcic sore throat from which she was recovering just before delivery.

A few cases of actinomycosis of the genitalia complicating pregnancy have been reported. The writer desires to call attention to the presence of parasitic infections of the vaginal canal, which occur quite frequently during pregnancy and which produce a considerable degree of discomfort and oftentimes an intractable leukorrhea. These infections are not generally recognized and are therefore not treated. The author refers particularly to vaginitis due to Trichomonas and to Monilia.

All infectious organisms gain entrance into the genitalia through either an exogenous or an endogenous route. Some of them, such as the gonococcus, are surface travelers, while others gain entrance through the lymphatics and through the blood stream. It is important to remember that certain portions of the mucous membrane of the adult female genital tract are very susceptible to infection, and by reason of their histologic arrangement the infection is difficult to eradicate. For example, Skene's tubules, Bartholin's ducts, and the cervical endometrium are very easily infected.

On the other hand, other portions of the mucous lining of the genital tract are, for all practical purposes, immune to infection. Thus, the adult vaginal and endometrial mucosa are relatively immune. DeLee, however, states that during pregnancy, owing to the succulence of the tissues, gonorrhea attacks the vulvar and vaginal epithelium.

Endogenous infection during pregnancy may result from intestinal infection, appendicitis, sore throat, or other foci, and may produce very serious consequences.

Adnexal inflammation, while generally considered a rare complication of pregnancy, occurs quite frequently, and is usually due to a lighting up of some latent infection which has antedated the pregnancy. Gradl states that there are no cases of hematogenous infection of the adnexa reported during pregnancy and believes that the heightened protection of the tissues, notably the hyperemia, prevents inception and spread of the infection at that time.

Leukorrhea is the commonest gynecological ailment and is, therefore, one of the commonest complications of pregnancy. One may state that prac-

tically every case of leukorrhea represents the handiwork of some of the organisms above mentioned, and that these organisms may work alone or in symbiosis. Inasmuch as gonorrhea is so frequent during the reproductive period, and inasmuch as it is so extremely common and so difficult to eradicate, the physician may assume that it *may* be the etiologic factor in any case where leukorrhea complicates pregnancy.

Gonorrheal organisms may remain latent and potentially infectious in the lower genital tract for years without being discovered, and while no accurate statistics are possible, the percentage of women who acquire this infection before they become pregnant must be very large.

In his examination of a pregnant woman the obstetrician should consider gonorrheal infection wherever profuse leukorrhea is present. However, he must not forget the rôle played by other infectious organisms in considering this complication.

Polak and others have called attention to the near certainty that chronic gonorrheal infection is present whenever a purulent secretion can be expressed from Skene's tubules, or whenever there is a reddening of the duct of Bartholin. Schmitz states that under normal circumstances the internal os serves as a barrier to keep infection out of the uterus, excepting during pregnancy, menstruation, and the puerperium. He advises against any manipulative procedures during these periods. Bodnar states that gonorrhea is just as infectious during pregnancy as any other time, but he considers that pregnancy affords a relative immunity to gonorrhea. The writer questions the suggestion that pregnancy immunifies the genital tract against infection.

In the management of gonorrhea during pregnancy one should assume a conservative attitude. In the acute stages rest in bed is of the utmost importance and has probably more to do in producing a cure than any other factor. Local treatment should be limited to ordinary cleansing of the vulva with soap and water or some other very mild antiseptic. Douching is contraindicated, unless most carefully supervised. However, there is no contraindication to treating with great care a skenitis or bartholinitis during pregnancy.

Curtis states that, in his experience, those who avoid cohabiting with carriers of gonococci, and avoid douching and sexual trauma, ordinarily recover from a first attack of salpingitis with relative promptness.

The management of persistent leukorrhea and other symptoms of chronic gonorrheal infections during pregnancy presents a vexatious problem to the practitioner, both as regards the positive recognition of the etiology and also the treatment. Direct examination of smears and the use of cultures are of inestimable value in determining the nature of the infection, and should be a routine procedure. It is the writer's opinion that any vigorous treatment is contraindicated because of the danger of producing abortion and of favoring the ascension of the infection.

Vaginal Trichomoniasis.—Within the last few years gynecologists and obstetricians have become much interested in vaginitis which is due to a unicellular flagellated organism, discovered by Donné nearly a hundred years ago. While the presence of trichomonads in the vaginal secretion has been reported by several workers since that time, it is only recently that serious attention has been given it as a cause of leukorrhea. It has been concluded by Bland and others that this condition occurs in about 20 per cent of all cases of pregnant women. The belief is also becoming more general

that this infection bears a definite relation to puerperal morbidity. The writer and many other observers have noted that a considerable percentage of women harbor this organism without any clinical manifestations, except during pregnancy. My associate has observed and treated a patient during her three pregnancies, in all of which she suffered severely from a Trichomonas vaginitis, while at other times she has had no symptoms whatever.

The writer believes that the general profession is not aware of the importance of this type of infection and, since his attention was called to it a few years ago, he routinely examines all pregnant patients for the presence of this parasite, where there is the slightest suspicion that it may be present. The primary symptom is a profuse, irritating, leukorrheal discharge which resists all ordinary methods of treatment. The vaginal canal and portio of the cervix are markedly congested and frequently present the papillary appearance suggestive of a strawberry. The discharge, which is usually of a yellowish color, may be quite copious and presents an "effervescence" which is believed to be due to a gas-forming organism that lives a parasitic existence on the trichomonad itself.

Fig. 506.—Photograph of mobile trichomonas. (Bland, Wenrich, and Goldstein in Surg., Gyn., and Obst., December, 1931.)

The diagnosis of this form of vaginitis can be readily verified by taking a drop of the secretion and mixing it with a few drops of normal salt solution and placing the mixture on a slide. Without staining the trichomonads may be distinctly seen under the microscope without difficulty; their characteristic motion, their change of shape, and other behavior render them easy of identification.

It is the opinion of the writer that in every case of vaginal trichomoniasis the patient should be treated if marked symptoms manifest themselves. Treatment will tend to relieve the irritating leukorrhea and will, to some extent, safeguard from puerperal morbidity. The method of treatment is by no means satisfactory and, while many remedies have been used, the writer knows of no specific.

At the present time the writer's treatment is as follows:

1. Careful cleansing of the entire vaginal mucous membrane with medicated soap after dilating the vagina with a wire speculum.
2. Thorough drying of the vaginal canal by the use of hot air.
3. Applying pyroligneous acid with a nasal spray to the vaginal canal.
4. Place carefully in the vagina a 4-inch bandage saturated with Lassar's paste.

This treatment is given every third day during the acute stage of the infection.

The home treatment consists in the administration at bedtime of a suppository containing picric acid, inserted into the vagina, followed the next morning with a vaginal douche consisting of mercury bichloride 1 : 4000.

Monilia Vulvovaginitis.—The writer has encountered a form of vaginitis due to Monilia with sufficient frequency to make him believe that the subject requires especial emphasis.

Plass states that the presence of Monilia in the vaginal secretion of the pregnant woman offers a definite avenue for the development of oral thrush in the newborn, through direct or indirect contamination of the mouth. He has shown experimentally that pure cultures from Monilia, isolated from vaginal secretions, result in clinical thrush when placed in the mouths of newborn infants and it is possible to recover the organism from the lesions

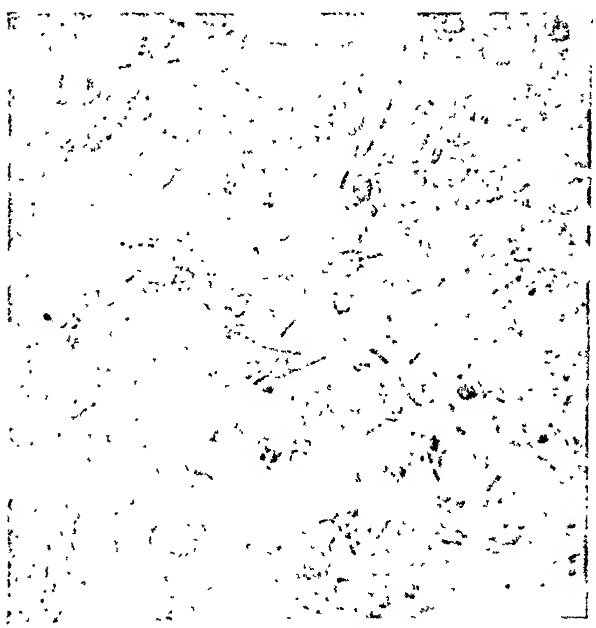

Fig. 507.—Monilia. Oil immersion.

thus produced. Plass further states that thus far experimental thrush has been developed only after the inoculation of one species of Monilia, namely, M. pinoyi, Castellani. Plass concludes that pregnancy and diabetes are definitely predisposing factors in Monilia infection and states that delivery usually leads to complete relief.

From the writer's personal experience he would describe the clinical picture of this form of infection as a deep congestion of the vulva, frequently with excoriation, with intense vaginitis involving the entire vaginal mucosa, which is covered by patches of a mildly adherent white exudate, which resembles in color and consistency a thin variety of cottage cheese. The removal of this exudate frequently exposes bleeding areas. The discharge is at times quite profuse. All the patients that the writer has observed suffered considerably from pruritus.

The treatment of this infection is not always satisfactory. Plass and

Nearly as many monographs on puerperal fever were published in the latter part of the eighteenth century and the early part of the nineteenth as appeared on all other phases of midwifery, and in addition journal and pamphlet articles numbered legion.[1] In spite of the plethora of writers on puerperal fever the first to make a substantial contribution and to indi-

Fig. 46.—Charles White. From a mezzotint engraving by W. Ward (1809) after portrait by Joseph Allen. (Courtesy of the University of Syracuse.)

cate lines of progress looking to the prevention of the disease was Charles White[2] (Fig. 46) (1728–1813), F. R. S., surgeon and man-midwife of Manchester, England.

[1] The bibliography of one section of Eisenmann's *Die Wund-Fieber und die Kindbett-Fieber* (Erlangen, 1837) numbers 370 titles.

[2] Charles White was born in Manchester, the son of Thomas White (1696–1776), an eminent surgeon and obstetrician, himself a licentiate of the Royal College of Physicians. After serving an apprenticeship with his father, he journeyed to London, where he enrolled as a pupil under William Hunter, to whom he later dedicated his book on midwifery. As early as 1760 he read two papers before the Royal Society and in 1762, at the age of thirty-three, was admitted to membership in that body of distinguished men. Of the greatest satisfaction to him and contributing not a little to his enjoyment of life was his association in the Manchester Literary and Philosophical Society with a coterie of brilliant Manchester lights, among whom may be mentioned John Dalton (1766–1844) and Thomas Percival (1740–1804). White contributed several papers to this Society which appear in its published *Memoirs*. Charles White died at his country home near Manchester, aged eighty-four, thus finishing, as his biographer, Thomas Henry, puts it, "a long life of unremitting exertion and of great and extensive usefulness."

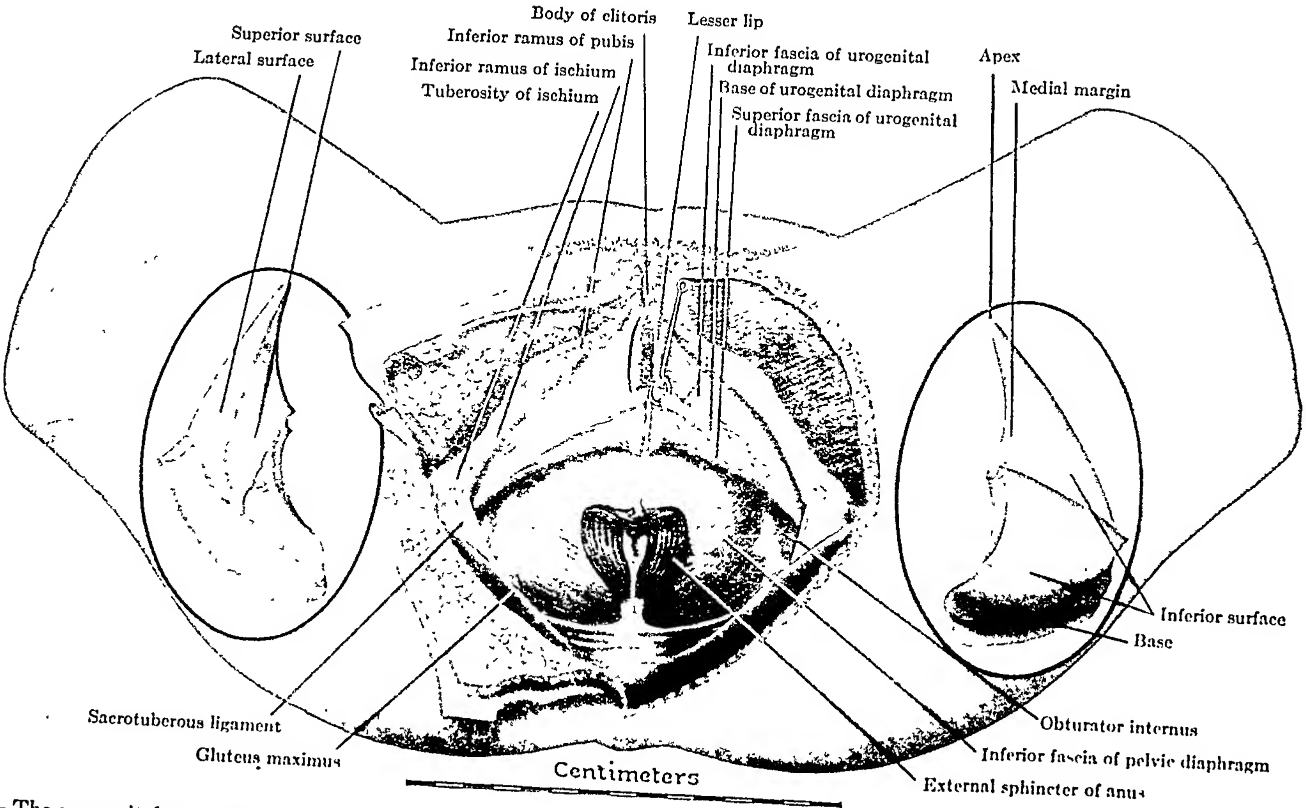

Fig. 83.—The urogenital and pelvic diaphragms, in the female perineum. The more superficial layers have been removed to show the urogenital diaphragm; the latter has been drawn forward, revealing the anterior continuation of the ischiorectal fossa, the superior boundary of which is the pelvic diaphragm. Insets: upper and lower aspects of a plaster cast of the left ischiorectal fossa, showing the extent and shape of the space.

thinks the hydatid degeneration is caused by the irritation of the villi by a previously existing endometritis.

Keller,[33] on the other hand, believes the vesicular degeneration of the villi is inherent in the ovum and due to malformation of the blood vessels of the villi. Some doubt is thrown upon the etiologic character of the condition by the limited extent of the mole, which would be expected to involve most of the villi if inherent in the ovum, while local areas of inflammation could account for the limitation. Whether the mole is cause or effect, the placental pathology can account for the faulty nutrition, the death of the embryo and the abortion.

Trauma.—The common belief that trauma is a principal factor in abortion is hardly tenable for we know that the uterus will endure shocking traumatic insults without aborting. Even after a large majority of surgical operations upon the pregnant woman, the uterus makes no attempt to expel its contents. The author has operated on many pregnant women with a negligible number of abortions. He once removed a very large bone hairpin from a three months' pregnant uterus, by vaginal hysterotomy, followed by no attempt at abortion. While trauma is an undoubted cause of abortion, its influence has been greatly overestimated.

If the ovum be carefully examined in cases attributed to accidents, it will usually be found that death of the fetus antedated the trauma and that the real cause of the abortion was the condition that caused the death of the fetus. Trauma sufficient to rupture the membranes is an undoubted cause of abortion (Huntington[31]). In most cases there must be something more fundamental than trauma, as is shown by the ease with which some women abort after the slightest shock, while others endure the grossest manipulations with impunity (Datnow[13]). Abernethy[1] could be certain of traumatic etiology in only 4 per cent and doubtful trauma in 20.8 per cent of his cases.

That those uteri which abort so readily are highly irritable, is hardly a satisfying explanation when we recall the fundamental causes of abortion.

Dietary Deficiencies.—The relation of dietary deficiencies, especially that of the vitamins to pregnancy, received a new impetus when Evans and Bishop[18] discovered the so-called "antisterility vitamin E." These authors and subsequent observers found that vitamin E starvation caused death of the embryo with disintegration and absorption of the placenta, membranes, and decidual tissue. Urner,[81] summarizing the literature and his own work, epitomizes the influence of each vitamin and concludes that in animals, and possibly in women, all of them are necessary to the completion of gestation. (For details see Urner's survey in Chapter XXI.) Jackson[32b] comprehensively reviews the status of dietary deficiencies. Barry[4a] discovered that in rats starved early in pregnancy the fetus died and was absorbed. Macomber[43a] and Vignes[83a] both demonstrated that calcium deficiency caused fetal death and abortion. Because so many women with wasting diseases gave birth to fully developed babies and for the reason that the American diet so generally furnishes all the needed food constituents, including the vitamins, we are likely to minimize the probabilities of dietary deficiencies being factors in sterility and abortion. The subject should not be dismissed without further investigation of women as well as of animals. As Urner says: "The value of a well-balanced diet should be emphasized during

or extravasated urine dissects its way, other routes being closed through the strength of fascial continuities and attachments.

The compartment contains the erectile or cavernous bodies of the clitoris and their investing muscles; in addition it is traversed by the vessels and nerves[1] (Fig. 81) which supply these structures, and by those which ultimately leave the space to reach the integument and the subcutaneous tissue of the labia. Through the compartment, in vertical direction and in the median plane, pass the terminal portions of the urinary and the genital tracts, partially subdividing the space into two.

Erectile Tissue.—It has already been stated that the only portions of the clitoris visible when the labia are retracted are the small conical end of the glans and the short body, the latter noticeable only as a low vertical ridge in the integument covering the lower part of the symphysis pubis. The other constituents of the erectile tissue, with their investing musculature, are housed in the superficial perineal compartment and are brought into view only when the deep layer of the superficial perineal fascia is removed (Fig. 81). The erectile bodies are composed of an intricate plexiform arrangement of vascular channels confined in definite masses by tough fibrous tunics. When incised, the cut surface displays channels in the form of cavities, and hence the tissue is referred to as cavernous.

Together the cavernous or erectile bodies form the clitoris (Figs. 81 and 82), and they are homologous, though in reduced and modified form, to the components of the penis in the male. The constituent parts of the female organ are the paired corpora cavernosa and the paired vestibular bulbs—the latter joined anteriorly to the glans. Each *corpus cavernosum clitoridis* corresponds to a *corpus cavernosum penis* in the male, but is much smaller; and, duplicating the condition in the male, the two corpora cavernosa unite in front to form the body of the clitoris (*corpus clitoridis*) and diverge behind as the crura (each a *crus clitoridis*). The vestibular bulb (*bulbus vestibuli*) of either side corresponds developmentally to a lateral half of the urethral bulb (*bulbus urethralis* of *corpus cavernosum urethrae*) in the male, but with the difference that the halves in the female remain separate and enclose the space of the vestibule.

The laterally placed corpora cavernosa, through their union anteriorly, form the small unpaired cylindrical body of the clitoris. The body, which measures 2 to 3 cm. in length, is bent upon itself and tapers somewhat distally, where it is covered by the glans. Although the two cavernous bars are enclosed in a dense fascial coat (*fascia clitoridis*) some degree of separateness between the symmetrical halves is effected by the clitoridal septum (*septum clitoridis*). As the body of the clitoris hangs down in front of the pubic symphysis it is provided with a suspensory ligament (*lig. suspensorium clitoridis*) which passes upward from it to the symphysis and onto the anterior abdominal wall. Behind, the two corpora cavernosa become completely separate as the crura, and are attached to the inner aspect of the pubic arch, or, more specifically, to the rami of the ischium and the pubis. Each is longer than the body, measuring about 4 cm. in length.

The rounded tubercle termed the glans, which constitutes the free extremity of the clitoris, possesses like the homologous male organ, a frenum and a prepuce (page 203). It is not, however, traversed by the urethra.

[1] Vessels and nerves; pages 238 to 250.

blows." That there must be many etiologic factors is attested by the fact that many apparently healthy women habitually abort.
What an attractive field for research!

PATHOLOGY

The proper treatment of abortion depends upon an exact understanding of the physiology and pathology of gestation during the first twenty-eight weeks. The physiology of the growing ovum is quite different before and after the complete formation of the placenta. Therefore, to fully under-

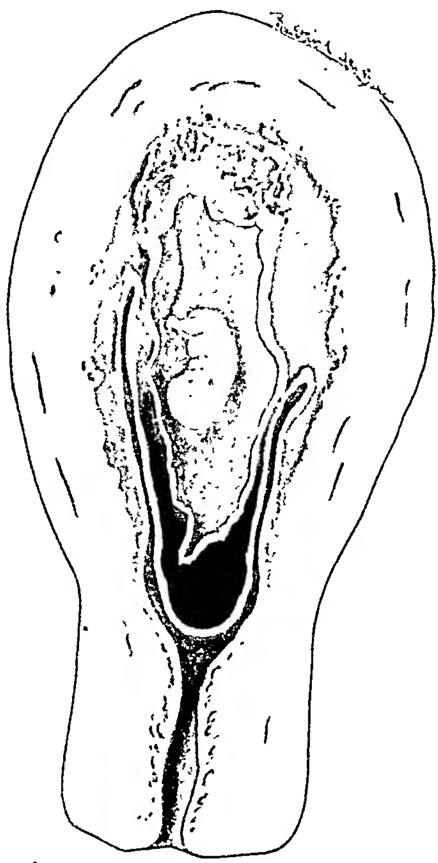

Fig. 508.—An inevitable abortion in the second month showing separation of both the decidua basalis and vera and hemorrhagic decidua reflexa. The internal os uteri is beginning to dilate.

stand the mechanism, pathology, and clinical aspects of abortion we must recall a few pertinent facts, particularly about decidual formation and implantation and placentation, details of which will not be repeated here, for they may be found elsewhere in this work. (See Chapters XII, XIII and XIV.)

When nidation occurs the ovum is for five or six weeks wholly within the decidua. During a similar period the villi gradually attach the ovum more and more firmly to the uterine wall until the placenta is completely formed. It is self-evident that an abortion in any of these different stages of placentation will have a different mechanism, pathology, and clinical picture and

require different treatment. It would seem logical then to designate abortions as occurring in:

1. The decidual stage, or early abortion, the first six weeks.
2. The attachment stage, or intermediate abortion, the second six weeks.
3. The placental stage, or late abortion, after complete placental formation and before the twenty-eighth week.

This classification immediately suggests what mechanism to expect, the pathologic conditions peculiar to each stage, the clinical course and the proper treatment.

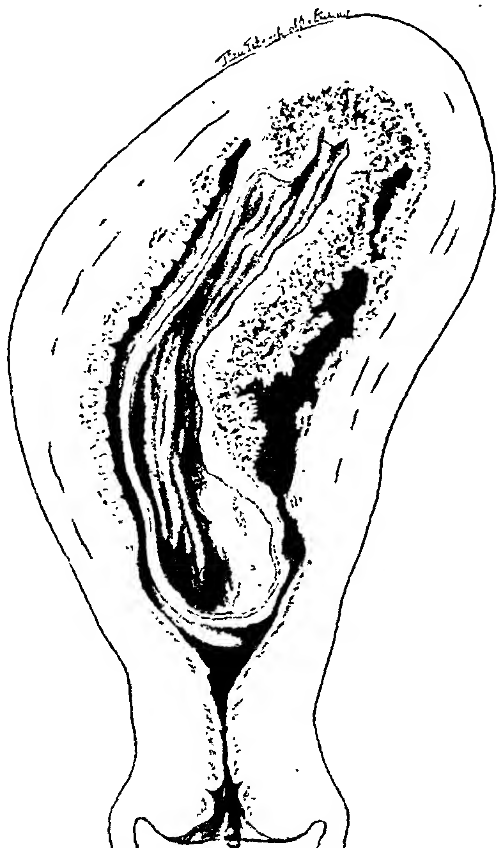

Fig. 509.—First stage of abortion at three months showing beginning separation of the placenta, upper portion still attached.

When the impregnated ovum burrows its way into the endometrium, decidua formation rapidly progresses, the villi erode the distended blood vessels, creating spaces in the decidua surrounding the ovum. It has no firm attachment to the uterus, being held chiefly by the enveloping decidua capsularis. This loose attachment explains why, in early abortion, the whole ovum, with its decidua, is so frequently expelled intact. Its union with the decidua is so loose that it is not uncommon to encounter an expelled intact sac containing a tiny embryo. At other times a fetus is seen which has broken through its decidua-surrounded membranes, still attached by the

umbilical cord, or the cord, being very weak, may be broken, the fetus being expelled alone and the decidua extruded later in one mass or in pieces.

During the second or attachment stage, while the "fastening villi" are firmly attaching the ovum to the uterus, the decidua basalis and the chorion

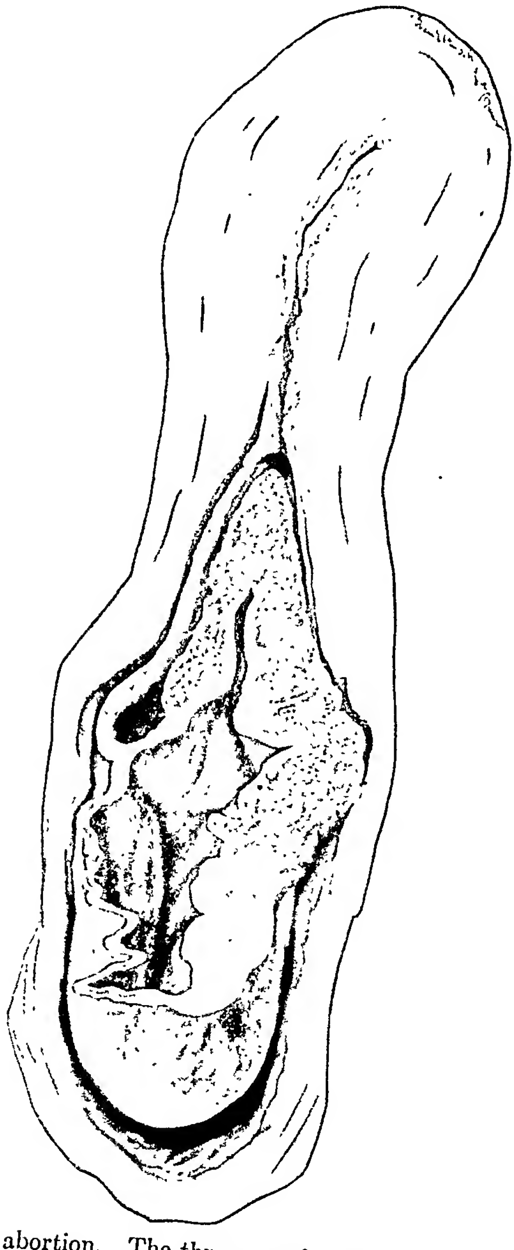

Fig. 510.—Second stage of abortion. The three-months-old ovum is completely separated and lying in the dilated cervix and upper vagina.

frondosum are, together, gradually developing into placenta, new venous sinuses are formed, the intervillous spaces enlarge and are filled with increasing amounts of maternal blood. If abortion occurs during this stage, there is, on account of the firmer attachment, a tendency for parts of the already partially formed placenta to be left in the uterus, even when the whole ovum

is apparently expelled. Not infrequently, the fetus is extruded and the entire amount of decidua or incompletely developed placenta remain attached to the uterus.

After the third month, when the placenta is completely formed as a discrete organ, it increases in size by peripheral growth and becomes thicker. Abortion, occuring during this stage, resembles the clinical course of normal labor although the process is often greatly prolonged, especially the dilatation of the cervix. The placenta, while expelled intact, often requires more time than after normal labor, because the stage has not been set by sufficiently strong contraction either to completely dilate the cervix or to readily separate and expel the placenta. In late abortion the complete ovum is rarely extruded intact.

Tissue Pathology in Abortion.—*The Embryo and Fetus.*—In early abortion the death of the embryo frequently antedates the expulsion by considerable time so it is usually found to be undergoing regressive changes, such as necrosis, and even entire absorption. At this time the tissues of the fetus are not far from embryonic; therefore, with death due to failure of proper nutrition, they are in a state favoring absorption. As gestation advances, the tissues lose their embryonic character. They have the benefit of good nutrition by establishment of the fetal circulation; consequently, abortion becomes less and less common as the complete formation of the placenta approaches. After placentation is complete, the embryo has become a fetus and has taken human form, firm functioning tissues have existed for some time and bones are present. Death of the fetus now results in a different pathologic process, the changes more nearly resembling those in adult tissues after death. General degeneration, maceration, and necrosis and decomposition begin almost at once after fetal death, and these progress rapidly. Rupture of the membranes and the consequent invasion of putrefactive germs hasten maceration and decomposition until the fetus and placenta may become a stinking mass with very foul discharge.

Syphilis, which is so commonly the cause of fetal death in late abortion, hastens disintegration of all the tissues of the fetus. Even if no infection be present, the fetus undergoes regressive changes until it softens into a dark red, almost shapeless mass—fetus sanguinolentus.

Very rarely all the soft parts of the fetus may disappear by degeneration and resorption until only the skeleton remains. This process, skeletonization and deposition of salts in the fetus, known as lithopedion formation, is more often found in abdominal pregnancies and missed abortion.

Decidua and Placenta.—In abortion, before the placenta is completely formed, when the decidua vera still covers the uterine walls, it is normal for decidua to be retained, but quite abnormal when parts of the amnion, chorion, villous clumps and trophoblastic masses remain. This causes irregular bleeding and subinvolution of the uterus. Remnants may be found in the uterus a long time after abortion. Ries found villi in the uterus after sixteen years. DeLee[15] found pieces of placenta at ninth months and Playfair at eleven months.

In early abortion the decidua usually degenerates, becomes liquefied and is either absorbed or passes off as a discharge, or it may become infected and, especially in criminally induced abortions, there results a purulent deciduitis, sometimes even a general sepsis. If portions of the decidua

remain attached and retain their nourishment, chronic deciduitis, of the hyperplastic or glandular or polypoid type, results. Whether the deciduitis is primary, resulting from a previous endometritis, or follows abortion, is controversial.

Moles.—When masses of chorion remain attached, they may become encapsulated by blood and fibrin, forming polypoid tumors, known as placental polyps, which consist of well-preserved, living villi with proliferating chorionic epithelium. When the ovum is not immediately expelled, it may, by a slow process of bleeding and coagulation, become encased in a large red blood clot called a blood mole. When fibrin covers the clot it is not red, but has more of the appearance of flesh, hence its name—fleshy or carneous mole. When the mole has hematomata under the chorion, it has a nodular appearance and has received various designations: ovum tuberculosum (Granville), tuberous subchorial hematomata, and hematoma mole (Taussig, BerryHart). Hydatidiform moles are also occasionally found. Streeter and Meyer reported frequent hydatid degeneration of villi in abortion. (See Missed Abortion, p. 1105.) In all types of moles the embryo is found in various stages of degeneration and absorption, or entirely absent.

Infarcts of the placenta are nearly always found, which is not surprising, for they occur in most normally functioning placentae, but in the placentae of abortion they are frequently seen in unusual number, especially in nephritis, syphilis, and tuberculosis. Calcareous deposits are seldom found in abortions unless the products of conception are retained for a long time. Inasmuch as syphilis is a very common cause of late abortion, we often find the typically larger syphilitic placenta, with its swollen clubbed villi, proliferated stroma and greatly reduced intervillous spaces. Endarteritis of the vessels of the villi is also, though rarely, observed.

SYMPTOMS AND DIAGNOSIS

Bleeding and pain are the two outstanding symptoms of abortion, but these vary according to the period of gestation and the type—threatened, imminent, inevitable, incomplete, infected, and missed abortion. When the patient is known to be pregnant, the diagnosis is usually made with ease by the symptoms. It may be quite difficult when gestation is doubtful. A differential diagnosis must then be made between other conditions which cause bleeding and pain. The existence of gestation can generally be decided by determining the presence or absence of the usual signs of pregnancy. (See Chapter XX.) If the ovum be alive the modified Aschheim-Zondek test offers strong evidence. It is necessary to determine the stage of gestation and the clinical type, because correct treatment cannot otherwise be chosen. The period of pregnancy can usually be determined by the history and the size of the uterus, unless the fetus died some time before symptoms of abortion began. Success will be measured by our ability to decide whether we are dealing with an early, intermediate, or late abortion. A threatened abortion or imminent abortion can sometimes be arrested. A complete extrusion requires no treatment; an incomplete abortion must be terminated.

Threatened Abortion.—One of the fine accomplishments of prenatal care has been the saving of fetal lives by the early recognition and prompt

treatment of threatened abortion through the instruction of mothers to report whenever they have premonitory symptoms of abortion, notably backache, urinary frequency, colicky pains in the lower abdomen, blood-tinged mucus, actual bleeding or pain. The cervix is softened, but usually not much dilated. If the fetus be alive, the chances of saving it are fairly good.

Imminent Abortion.—When the bleeding is profuse, the cramps approach the character of labor pains or the cervix is greatly softened and considerably dilated, the abortion becomes "imminent." Even with these severe symptoms it is not impossible to save the pregnancy. Often when the case appears most hopeful, the abortion is inevitable because the fetus is dead. When in doubt, employ the Aschheim-Zondek test, which becomes negative when the ovum dies. Anxiety, useless effort and blood loss may thus be avoided.

Inevitable Abortion.—When the membranes rupture and the amniotic fluid escapes, the abortion is always "inevitable," but it may also be recognized as beyond control without escape of the liquor amnii, when the hemorrhage remains profuse, the pains increase and the cervix continues to dilate in spite of treatment.

Complete Abortion.—When the intact ovum is expelled, the abortion is said to be "complete." In this event, bleeding and pain cease and the woman goes on to recovery.

Incomplete Abortion.—The expulsion of the whole ovum with the decidua is much more likely to occur in the first six weeks of pregnancy, when the attachment is not yet firm. Rarely, even if the pregnancy is farther advanced, but the placenta not yet complete, the ovum may yet be expelled intact. Much more frequently the fetus is expelled and the secundines remain, in which case more or less bleeding persists until they are spontaneously extruded or are artificially removed. If, during this early period, only the sac covered with shaggy villi be extruded, the entire decidua then remains, but it is relatively scanty and will usually gradually escape in the lochia with little bleeding. However, when the fetus escapes, leaving nearly all the decidua still in the uterus, there may be considerable bleeding until the uterus succeeds in its secondary expulsive efforts, or, on account of the amount of hemorrhage, artificial emptying of the uterus may be required. The diagnosis may be made by examining the extruded portions to determine what may be left in the uterus, or by palpating the ovum or parts of it in the cervical canal. Expelled masses may be recognized as parts of the ovum by their arborescent appearance when floated in water. When macroscopical evidence fails the microscope will identify the villi by their unmistakable syncytium or decidua, the large cells crowded together in their typical mosaic pattern. By bimanual examination the uterus, except in early abortion, will be large and soft. If in doubt as to the contents of the uterus, one is justified in dilating the cervix and thoroughly exploring the cavity with the gloved finger, under anesthesia if necessary.

Cervical Abortion.—The rather unusual freakish behavior of the cervix, when the external os resists dilatation, results in the retention of the ovum in the otherwise dilated cervix. This is termed "cervical abortion." It is characterized by a very small or entirely undilated external os, while the rest of the cervix is bulged, accompanied by moderate, persistent bleeding. The

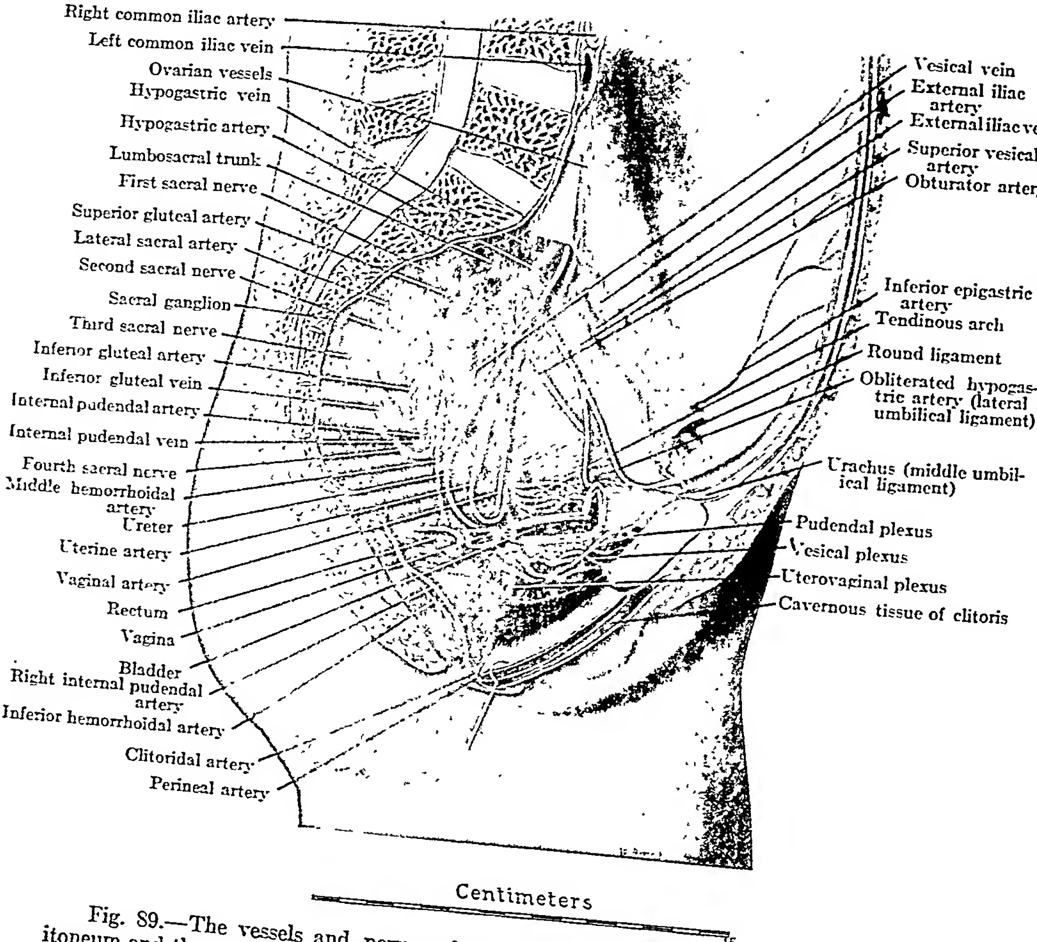

Fig. 89.—The vessels and nerves of the left half of the female pelvis. The peritoneum and the extraperitoneal fatty tissue have been removed, and the viscera partially cut away.

for it is well known that the mildest humours in the human body, if suffered to stagnate, become so, as soon as the air has access to them. These are in part absorbed by the lymphatics in the womb and vagina, . . ."

"The danger does not arise from the smallness of the quantity of the discharge, but from its stagnation, whereby it becomes putrid and in this state is again absorbed into the circulation."

To remedy this condition he instituted the principle of uterine drainage by placing his patients in a sitting position shortly after delivery.[1] In order to accomplish this, he employed a bed (Fig. 48) manufactured in Birming-

A

TREATISE

ON THE

MANAGEMENT OF PREGNANT

AND

LYING-IN WOMEN,

AND THE MEANS OF CURING, BUT MORE ESPECIALLY

OF PREVENTING THE PRINCIPAL DISORDERS

TO WHICH THEY ARE LIABLE.

TOGETHER WITH SOME

NEW DIRECTIONS

CONCERNING THE

DELIVERY OF THE CHILD AND PLACENTA

IN NATURAL BIRTHS.

Illustrated with CASES.

By CHARLES WHITE, F.R.S.

Member of the Corporation of Surgeons in London, and Surgeon to the Manchester Infirmary.

LONDON:

Printed for EDWARD and CHARLES DILLY, in the Poultry.

MDCCLXXIII.

Fig. 47.—Facsimile of the title page of *A Treatise on the Management of Pregnant and Lying-in Women* by Charles White, London, 1773.

ham, the invention of "Doctor Vaughan,[2] an ingenious physician at Leicester," an engraving of which appears in the several editions of his book on midwifery. The illustration shows a modern back-rest capable of adjustment

[1] The credit for postural surgical drainage has been accorded to George Ryerson Fowler (1848–1906) and in surgical literature the position is widely known as the "Fowler position." Fowler described the position as favoring the localization of peritoneal infections in the pelvis, drainage being provided surgically. In strict priority, however, this position involving the drainage principle should be known as "White's position."

[2] James Vaughan (1739–1813), M. D., Edinburgh, 1762; practiced in Leicester for nearly forty years; physician to the Leicester Infirmary; father of Sir Henry Halford (1766–1844); Bart., G. C. H., M. D., who was president of the Royal College of Physicians from 1820 to the year of his death, 1844.

time of the expulsion of the ovum, or its artificial removal, is much more dangerous than in the case of an ordinary spontaneous abortion. This is not altogether due to the lack of tone of the uterine muscle, but to hyaline degeneration of the blood vessel walls and to infiltration of the muscle with connective tissue, rendering contraction difficult or impossible.

Diagnosis.—The diagnosis is not attended by any unusual difficulties of technic or interpretation. The many failures to diagnose missed abortion seem to show a lack of knowledge on the part of many physicians of the existence of this condition rather than a lack of technical diagnostic skill. Matthews Duncan,[17] master teacher of the art of diagnosis, put it very forcibly: "I do not know of any subject better than missed abortion for illustrating the value or necessity of extensive knowledge with a view to good diagnosis. *If you do not know a thing, you are almost certain not to find it.*" This possibility should be strongly suspected when a woman has skipped one or two menstruations, then has had symptoms of a threatened abortion which have subsided and the uterus has ceased to increase in size. The lack of growth of the uterus can be determined by two examinations, made a month apart, or by comparing the size of the uterus with the size it ought to be for the supposed period of gestation. If there be a lack of a combination of symptoms pointing to missed abortion, particularly if toxic symptoms are wanting, it may be wiser to wait even two months. The irregular bleeding may lead the woman to think she is not pregnant. The condition may then be mistaken for malignancy. Todd[50] reports a case where an eminent specialist diagnosticated a malignant growth and advised removal of the uterus at once. Any woman of the childbearing age, who has suppression of the menses, irregular or atypical menstruation, toxic symptoms, such as malaise, loss of appetite, chilliness, foul taste in the mouth, anorexia, loss of weight, particularly afternoon temperature, and who is in a general state of invalidism, should always have the possibility of missed abortion excluded before concluding that she has tuberculosis, syphilis, focal infection, or cancer.

Excellent physicians and even well-trained internists may miss the diagnosis, not from lack of skill, but from the lack of knowledge that "missed abortion" is always a possibility with skipped and irregular menstruation and obscure invalidism, especially if there is an afternoon rise in temperature.

Prognosis.—A condition which has constantly the potential danger of alarming hemorrhage, chronic invalidism and possible death cannot be considered lightly. That these very real dangers exist and that missed abortion has a definite mortality is well illustrated by Rosenstein's fatal case from hemorrhage,[63] Duncan's case of excessive bleeding, and the author's[59] experience with a woman in good health up to the time of her missed abortion, which resulted in invalidism from which she never recovered, finally terminating with tuberculosis.

Treatment.—With such a potentially bad prognosis, expectant treatment cannot safely be prolonged. In the early months of a missed abortion it may be safe or even necessary to wait one or two months to establish a certain diagnosis. But as the case is prolonged the dangers increase. Therefore, the uterus should be emptied as promptly as possible when the diagnosis is established. Until the early part of this century a waiting policy was more apt to be followed, but in 1908, Rosansky[66] advocated immediate empty-

ing of the uterus, to which opinion Rosenstein was driven by his fatal case, going so far as to advise vaginal hysterectomy in cases of long standing.

The author is thoroughly convinced, by his own limited experience and by a study of the literature from 1878 to 1932, that missed abortion is a much more serious condition than is generally supposed and that we are not justified in exposing our patients to the dangers of permanent ill health, or even death, by allowing them to go on indefinitely, in the hope of spontaneous termination.

Methods.—If the simpler methods of inducing expulsion fail, the cervix should be artificially dilated, the contents removed and on account of the great tendency to postoperative bleeding, in selected cases the uterus should be packed. The inexplicable indolence of the uterus, which has caused the retention of the dead ovum, persists after its contents are removed, rendering it incapable of properly contracting enough to stop bleeding as it does after complete abortion. Often the cervix resists dilatation inordinately; therefore, if difficulty is met in dilating one should not persist in attempts to dilate, but a hysterotomy (vaginal cesarean section) should be performed at once.

PREMATURE LABOR

Labor occurring after the twenty-eighth week is considered premature. The causes are similar to those of late abortion, such as syphilis, chronic nephritis and other toxemias, placenta praevia and excessive hydramnios. Of questionable etiologic significance are heart lesions, lung infections and cervical operations, unless an unskilled operator has done too high an amputation. Syphilis causes approximately half of the premature labors, more than all other causes put together. If prenatal care had done nothing else than the early detection and treatment of syphilis, it would be worth all the effort expended.

While the course of labor is much the same as at full term, malpositions are more frequent and the labor prolonged by weak pains. The third stage of labor is frequently not normal and involution is almost always slower. Premature labor is sometimes artificially induced in the interests of both mother and child. (See Chapter XLI.)

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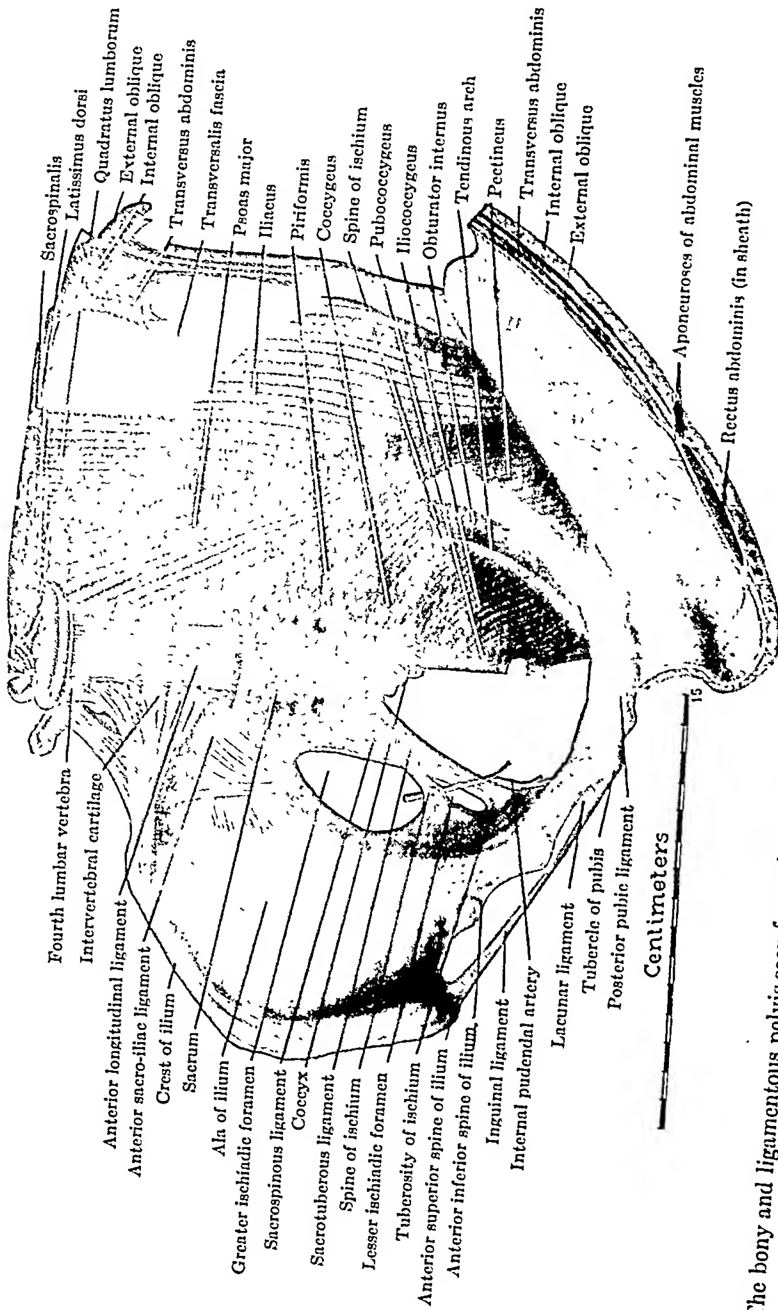

Fig. 92.—The bony and ligamentous pelvis seen from above and in front. The dorsal axial and the anterolateral abdominal muscles are also shown.

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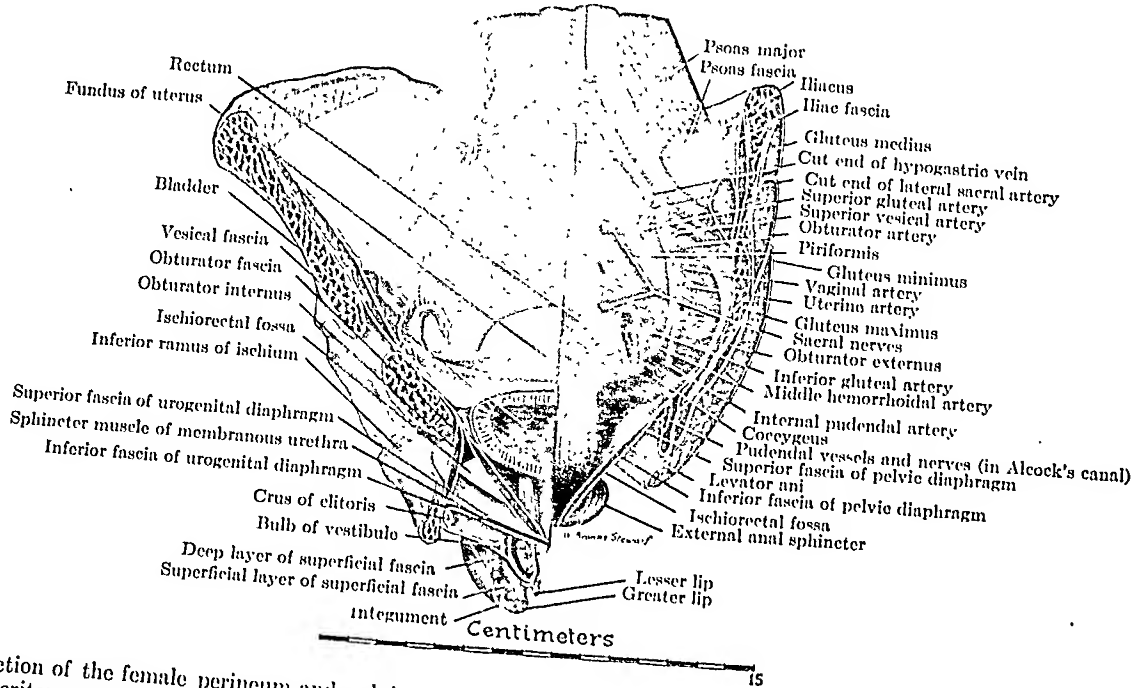


Fig. 95.—Coronal section of the female perineum and pelvis, on the left through the anal, on the right the urogenital, part of the perineum. On the right the peritoneum and the fascial layers are intact; the superficial fatty tissue has been removed from both ischiorectal fossae.

larged epithelial cells forming the *stratum granulosum;* the cells of the granular stratum become filled with droplets of a yellowish fatty pigment, and are therefore known as lutein cells. They form a zone of macroscopical size, and the entire body is then known as the *corpus luteum.* Unless pregnancy occurs, it gradually degenerates; the cells lose their characteristic color and are replaced by connective tissue. Through contraction, the structure is converted into a whitish fibrous nodule, the *corpus albicans.* The development and maturation of the follicles and ova continue without interruption from the time of puberty throughout the childbearing period.

EPOOPHORON AND PAROOPHORON.—Portions of the mesonephric (wolffian) tubules and duct in the embryo persist in the adult female as a group of vestigial structures lodged between the peritoneal layers of the broad ligaments; these persistent embryonic structures are the epoophoron, the paroophoron, the vesicular appendages, and duct of Gärtner.

The epoophoron (parovarium or organ of Rosenmüller) lies in the lateral part of the mesosalpinx (Fig. 96), between the uterine tube and the ovary. It is a flattened structure, trapezoidal in outline consisting of from eight to twenty small tubules joining a main common duct at approximately right angles. The several short ducts (*ductuli transversi*) are narrow and tortuous; they begin with blind and somewhat dilated ends near the hilum of the ovary, and following a diverging course toward the uterine tube, open into the single longitudinal duct (*ductus epoophori longitudinalis*). The latter canal runs parallel to the uterine tube, ordinarily corresponding in length to the epoophoron itself, and being closed at each end. In exceptional cases, however, it may be prolonged in either or both directions; medially as the duct of Gärtner, laterally to the vesicular appendages. The duct of Gärtner may extend as a continuation of the longitudinal duct of the epoophoron along the oviduct and uterus, finally piercing the lateral wall of the vagina close to the hymen. In the opposite direction, the duct may sometimes reach the so-called vesicular appendages (*appendices vesiculosi;* hydatids of Morgagni), which are one or more pedunculated cysts the size of peas hanging free from the anterior surface of the broad ligament in the region of the infundibulum.

Just medial to the epoophoron, and, likewise, in the mesosalpinx, is located the paroophoron, a small round rudimentary organ distinct only in the very young. It consists of a few scattered tubules, not unlike those in the epoophoron.

The tubules of the paroophoron and the transverse ductules of the epoophoron are remnants of the mesonephric (wolffian) tubules; the longitudinal duct of the epoophoron and the duct of Gärtner are persistent portions of the lower end of the mesonephric duct of the embryo, while the vesicular appendages are derivatives of its upper end.

Each of the several vestigial structures finds its homologous counterpart in the genital tract of the male; the transverse ductules of the epoophoron represent the efferent ducts of the testis; the longitudinal duct corresponds with the duct of the epididymis, Gärtner's duct with the ductus (vas) deferens, while the vesicular appendages are the representatives of the appendix, of the testis, or paradidymis (organ of Giraldes).

VESSELS AND NERVES OF PELVIS AND PERINEUM

The major portion of the course of all the vessels supplying structures within the pelvis lies in the extraperitoneal fatty tissue which intervenes between the peritoneum and the fascia covering the deep surface of the musculature. The nerves on the contrary lie at first outside the fascia; they are not only retroperitoneal, as are the vessels (and viscera) but also "retrofascial" (like the muscles). Therefore, the visceral branches of the vessels pierce the fascia once—in penetrating the reflection of it which is carried upward from the pelvic organs; likewise the parietal branches pierce it but once, as they pass from the pelvis to the perineum, carrying prolongations of the fascia which blend with their adventitial coats. The nerves supplying the organs must pierce the fascia twice; once as they emerge from the bony foramina or leave the ganglia of the sympathetic chain, and again as they enter the substance of an organ; those destined for the perineum, in leaving the pelvis, do not have to pierce the fascia since they already lie outside it.

"Out of the whole number of lying-in patients whom I have delivered (and I may safely call it a great one) I have never lost one, nor to the best of my recollection, has one been greatly endangered by the puerperal, miliary, low nervous, putrid malignant or milk fever. . . . I have, however, the pleasure to observe that those fevers, in this neighborhood at least, have of late years greatly decreased. This must chiefly be attributed to a system of management lately introduced, much to the honour of our present practitioners."

Throughout his treatise, White refers to puerperal fever as putrid fever, and as Cullingworth points out, antedates James Y. Simpson in recognizing its similarity to so-called "surgical fever" when he says:

"Every surgeon conversant with his business knows that a rapid pulse (*i. e.*, fever) never fails to attend absorption of matter from abscesses or ulcers, whatever be the other concomitant symptoms. If to these considerations we add that, as the puerperal fever is more fatal in large cities and crowded hospitals than in places where the air is more open and pure, so is the fever occasioned by the absorption of matter . . . (and) that as

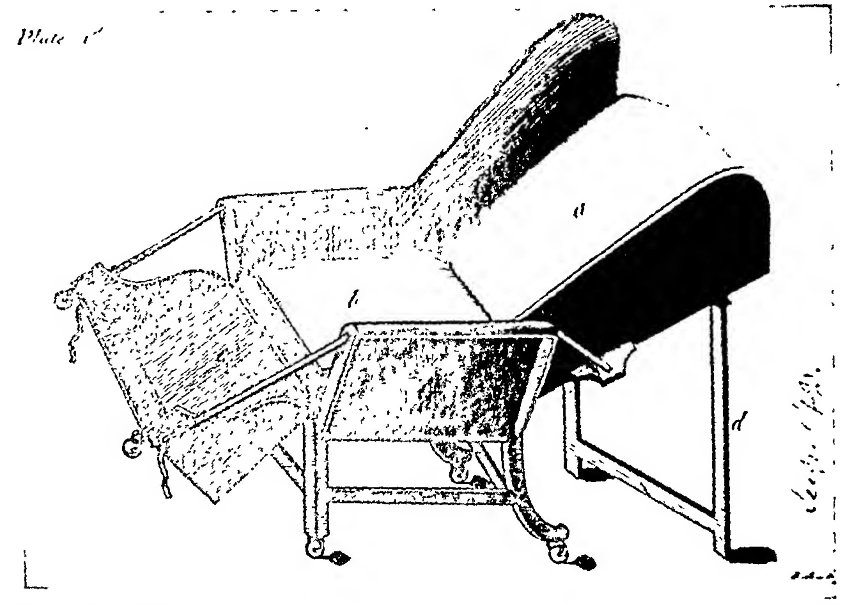


Fig. 49.—Adjustable reclining chair. From plate accompanying the *Treatise* by Charles White, London, 1773.

the puerperal fever does not appear till after delivery, so neither does absorption of matter from an abscess till it be opened and the air have access, we may, I think, conclude that the absorption of matter is the immediate cause of the puerperal fever . . ."

In a brief discussion it is impossible to detail the various modes of treatment evolved, yet it is interesting to note that in the appendix published in the second edition of Charles White's book, he advocates the removal of putrid matter through irrigation with mild antiseptic solutions. He says:

"I must not omit to mention in this place the good effects I have experienced from emollient or antiseptic injections into the uterus, by means of a large ivory syringe or an elastic vegetable bottle. In those cases where the lochia have become acrid or putrid and, by being absorbed into the circulation, have served as a constant fomes to the disease, I have by this means known the fever much assuaged, and in many cases wholly extinguished; for though, as I have before observed, the quantity of the lochia is not to be much regarded, the quality of this discharge is a matter of infinite importance."

Thomas Kirkland (1722–1798), a former pupil of Smellie, six years older than Charles White, his friend and correspondent, had been urged by White to record his observations on puerperal fever. It was Kirkland's intention to publish his notes as a supplement to White's treatise (1773), but not completing the manuscript in time, his monograph was issued separately in 1774[1] (Fig. 50) and dedicated to Charles White. The late Sir William Sinclair in his eulogistic life of Semmelweis[2] boldly says:

A

TREATISE

ON

CHILD-BED FEVERS,

AND ON THE

METHODS OF PREVENTING THEM,

BEING A

SUPPLEMENT

To the BOOKS lately written on the SUBJECT,

TO WHICH ARE PREFIXED

TWO DISSERTATIONS,

The one on the BRAIN and NERVES; the other on the SYMPATHY of the NERVES, and on different Kinds of IRRITABILITY.

By THOMAS KIRKLAND, M. D.

Rationalem quidem puto medicinam esse debere; instrui vero ab evidentibus causis, obscuris omnibus, non a cogitatione artificis, sed ab ipsa arte rejectis. CELSUS.

LONDON,
Printed for R. BALDWIN, No. 47, and W. DAWSON, No. 7, Pater-noster-Row,
MDCCLXXIV.

Fig. 50.—Facsimile of the title page of the *Treatise on Child-Bed Fevers*, by Thomas Kirkland, London, 1774.

"Thomas Kirkland was the first man in this world to enunciate the true etiology, the import and the prophylaxis of puerperal fever."

In Kirkland's dedication addressed to Charles White, he lays down what he considers the chief points of difference between his belief and that of many of his contemporaries.

"I must confess, Sir, I cannot approve of the modern doctrine, which asserts that the puerperal fever is a disease *sui generis* . . ."

This dogmatic assertion, so contrary to contemporary opinion, Kirkland proceeds to elaborate and a fairly careful reading of his treatise discloses

[1] *A Treatise on Child-bed Fevers and on the Methods of Preventing Them*, London, 1774.
[2] *Semmelweis; His Life and His Doctrine*, Manchester, 1909.

"as the fever does not always accompany the puerperal state, nor is the disease always confined to the female sex."

In a note to this remark he states:[1]

"The author has seen many cases of this disorder, not only in the pregnant state, but some in men; and has been present at the dissection of bodies, who fell victims to the disease in both instances; where not only the general diagnostic symptoms had been, but the morbid appearances after death were also the same as he has generally met with in a multiplicity of cases of puerperal fever, and in many dissections of bodies who died in it."

Philip Pitt Walsh endorses Kirkland's position when he says:[2]

"I will venture, previous to adducing the proofs, to assert, that the disorder is not one *sui generis*, confined to INLYING WOMEN, but merely an unusual form of a very common disease, and is, in reality, no other than the common infectious fever, complicated with a more or less extensive inflammation of the peritonæum."

Walsh further emphasizes the necessity of prompt segregation of the infected cases and the desirability of absolute cleanliness in the lying-in wards.

Again in the writings of **Alexander Hamilton**[3] (1739–1802) we find this statement:[4]

"The bed-chamber of the lying-in woman should be large and airy, and fresh air should be freely admitted, only observing that it does not blow on her in a stream; . . . nor should the chimney be closed with any chimney-board; the aperture from the vent, unless it be placed very near the bed, makes a useful ventilator, by which a free circulation of refreshing cool air is regularly supplied."

Relative to the infectious character of child-bed fever, Hamilton says:

"The child-bed fever is remarkably infectious; and, when epidemic, capable of being propagated from one person in the puerperal state to another, and its event is generally so fatal, that, like the plague, few escape of those affected . . . in public hospitals, and where a number of women are crowded together. It raged in the public hospitals of Paris, London, and Dublin, communicating from one person to another with astonishing rapidity, and its ravages were equally striking."

In order to indicate the widespread interest in sanitation, absolute cleanliness of the lying-in wards, the surroundings of the patient and isolation of infected cases, we must note the emphasis upon these factors in the writings of **John Clarke** (1761–1815), Thomas Young and John Armstrong (1784–1829). From these citations we may conclude that British obstetricians generally recognized the importance of cleanliness. John Clarke in his *Practical Essays on the Management of Pregnancy and Labour; and on the Inflammatory and Febrile Diseases of Lying-in Women*[5] quotes Joseph Clarke of Dublin as follows:

[1] *The Principles and Practice of Midwifery.* By Edward Foster. Completed and corrected by James Sims, London, 1781.

[2] *Practical Observations on the Puerperal Fever: wherein the nature of that disease is investigated, and a method of cure, which has hitherto proved successful, recommended.* London, 1787.

[3] Alexander Hamilton was professor of midwifery at Edinburgh University from 1780 to 1800; deacon of the Edinburgh College of Surgeons, and chief founder of the Lying-in Hospital, 1791.

[4] *A Treatise on Midwifery*, etc., London, 1781.

[5] London, 1793.

1795. Gordon's treatise is dedicated to his friend and teacher, Thomas Denman. In Oliver Wendell Holmes' essay on puerperal fever,[1] Gordon is justifiably accorded a position of outstanding importance. Gordon's treatise is based upon his experience with the Aberdeen epidemic of 1793. He appears

A

TREATISE

ON THE

EPIDEMIC PUERPERAL FEVER

OF

ABERDEEN.

BY

ALEXANDER GORDON, M. D.

PHYSICIAN TO THE DISPENSARY.

LONDON:

PRINTED FOR G. G. AND J. ROBINSON, PATERNOSTER ROW.

1795.

Fig. 51.—Facsimile of the title page of *A Treatise on the Epidemic Puerperal Fever of Aberdeen* by Alexander Gordon, London, 1795.

to have been fairly familiar with the literature and here, too, many of his statements appear to be those of a modern writer. In discussing the analogy between puerperal fever and erysipelas, he states that while

and attended the surgical practice and lectures on surgery and dissections at the Westminster Hospital under Dr. John O. Justamond (c. 1775). Returning to Aberdeen in 1785, he obtained the degree of M. D. from Marischal College, and settled in general practice in that city. He was soon after appointed physician to the Dispensary there, which office he held for ten years. He devoted himself particularly to midwifery, in which his practice became considerable, and on which, for several years, he gave an annual course of lectures to the medical students. Soon after the publication in 1795 of his *Treatise on the Puerperal Fever*, Dr. Gordon was called on active duty by the Admiralty. His health failing he was invalided; and returned to Aberdeenshire where he died October 19, 1799. Dr. Gordon left a large collection of manuscript papers on various professional subjects; among others are *Lectures on Midwifery and the Diseases of Women and Children* which occupy three volumes, folio; and a *Treatise* in four volumes, quarto, on the practice of physic, which last it was his intention to publish.

[1] *The Contagiousness of Puerperal Fever. New England Quarterly Journal of Medicine and Surgery.* Vol. i. Boston, 1843.

With reference to other diseases, Denman continues:

"The nature and the power of contagion in general seem not to be perfectly understood, and it may exist in many diseases, in which it has not yet been suspected. This subject is therefore deserving of the most serious investigation and inquiry."

The relation between puerperal fever and erysipelas had been noted by innumerable observers. George Hume Weatherhead (1790?–1853), writing in 1819,[1] describes the pathology of puerperal fever as identical with that of erysipelas. Quoting Michael Underwood[2] (1736–1820) he says:

"Upon examining several bodies after death (of those who had died of erysipelas infantile), the contents of the belly have frequently been found glued together, and their surface covered with inflammatory exudation, EXACTLY SIMILAR TO THAT FOUND IN WOMEN WHO HAVE DIED OF PUERPERAL FEVER."

Weatherhead concludes:

"But without endeavouring to exhaust the subject, some practical advantage, I think, may be derived from the facts and opinions I have stated, should erysipelas and puerperal fever be only modifications of the same morbid action. For example, where these two diseases are epidemic in the same place, at the same time, caution must be had in going from the bed-side of an erysipelas patient, to that of a woman after delivery; and it is to the unwitting neglect of this precaution, that I would ascribe the propagation of the disease in its two modifications, notwithstanding the care which has been taken by some practitioners to change their clothes and use ablutions after having visited a patient with puerperal fever—I say this will be unavailing, if the same care be not taken after having visited an erysipelatous patient."

Clinical evidence that erysipelas and puerperal fever had a common origin had been accumulating. Claude Pouteau[3] (1725–1775) in 1750 called puerperal fever "epidemic erysipelas of the peritoneum." This position was concurred in by William Lowder[4] (d. 1801), a London lecturer on midwifery, by John Abercrombie[5] (1780–1844), by Charles Waller (1802–1862), Robert Lee[6] (1793–1877) and many others. Too frequently had they observed the

[1] *An Essay on the Diagnosis between Erysipelas, Phlegmon and Erythema*, etc., London, 1819.

[2] Michael Underwood studied in London and Paris, practicing in London as a surgeon and later (1784) as a man-midwife.

[3] Claude Pouteau (*Œuvres Posthumes de M. Pouteau, chirurgien en chef de l'Hôtel Dieu de Lyon*, 3 vols., Paris, 1783) in a chapter "on the means of obviating in hospitals the danger of inoculating various forms of virus by means of dressings" (vol. iii, p. 227) points out numerous instances of infection conveyed by soiled dressings. In order to obviate this he advised dressings largely composed of paper by means of which the medicament used was applied to the wounded surface. As soon as this dressing became soiled it was promptly destroyed and a fresh dressing applied. His method of disposal of infected dressings is distinctly modern. He published *Mélanges de chirurgie*, Lyon, 1760.

[4] William Lowder received his M. D. from Aberdeen in 1775; was admitted a licentiate of the College of Physicians, 1786. He was a well-known lecturer on midwifery in St. Saviour's churchyard, Southwark.

[5] John Abercrombie received his M. D. from Edinburgh in 1803; studied at St. George's Hospital, London. He practiced in Edinburgh and in 1824 was appointed physician to the king of Scotland.

[6] Robert Lee received his M. D. from Edinburgh in 1814. He served as physician to Prince Woronzow, governor-general of the Crimea, 1824–1826; was lecturer on midwifery and diseases of women at St. George's Hospital from 1835 to 1866. He was elected to the College of Physicians in 1841; Lumleian lecturer, 1856–1857; Croonian lecturer, 1862; Harveian orator, 1864.

1877), A. C. Baudelocque,[1] George Moore[2] (1803–1880), William Campbell[3] (1788–1848), and Edward Rigby[4] the younger (1804–1860). Some few extracts from these writers will show the trend of clinical thought for the first four decades of the nineteenth century.

For example, Robert Gooch says

"It is not uncommon for the greater number of cases to occur in the practice of one man, whilst the other practitioners of the neighbourhood, who are not more skilful or more busy, meet with few or none. A practitioner opened the body of a woman who had died of puerperal fever, and continued to wear the same clothes. A lady whom he delivered a few days afterwards, was attacked with and died of a similar disease; two more of his lying-in patients, in rapid succession, met with the same fate; struck by the thought that he might have carried the contagion in his clothes, he instantly changed them, and met with no more cases of the kind. A woman in the country, who was employed as washerwoman and nurse, washed the linen of one who had died of puerperal fever; the next lying-in patient she nursed died of the same disease: a third nursed by her met with the same fate, till the neighbourhood, getting afraid of her, ceased to employ her. The disease has occurred in some wards of a hospital, the others being free from it; but after ventilating, cleansing, and painting these wards, they became as healthy as the others. Facts such as these have long led to the suspicion that the disease might be communicated from one lying-in woman to another in the clothes of the practitioner or nurse, or the furniture of a tainted chamber."

Again Gooch says in describing the epidemic that occurred in 1824:

"In the winter of the year 1824, puerperal fever was prevalent and fatal in London and its neighbourhood. I had resigned my office at the Westminster Lying-in Hospital, and did not know, or do not remember, what was going on there; but I saw this disease repeatedly in consultation, and heard of it among my medical friends. Several instances occurred of its prevalence among the patients of particular practitioners, whilst others who were equally busy met with few or none. One instance of this kind was very remarkable: a general practitioner in large midwifery practice lost so many patients from puerperal fever, that he determined to deliver no more for some time, but that his partner should attend in his place. This plan was pursued for one month, during which not a case of the disease occurred in their practice. The elder practitioner being then sufficiently recovered, returned to his practice, but the first patient he attended was attacked by the disease and died. A physician, who met him in consultation soon afterwards about a case of a different kind, and who knew nothing of his misfortune, asked him whether puerperal fever was at all prevalent in his neighbourhood, on which he burst into tears, and related the above circumstances."

Auguste César Baudelocque (1795–1851) (a nephew of Jean Louis Baudelocque), whose treatise was awarded the prize of the Royal Society of Medicine of Bordeaux, notes that the introduction of the hand into the parturient canal, and the use of instruments, must be considered in the etiology of puerperal fever—"the influence of which I cannot for a moment contest":

"Peritonitis is to be particularly apprehended, when, during the operation employed for the extraction of the child or placenta, there occurs any laceration of either the vagina or uterus. I will even remark that, in this latter case, or after the Cæsarean operation, the inflammation of the peritoneum is inevitable. . . .

"It would be curious to ascertain in what proportion the disease has declared itself with regard to the number of accouchements effected by the interference of art:"

[1] *Treatise on Puerperal Peritonitis.* Translated by G. S. Bedford. New York, 1831.

[2] *An Enquiry into the Pathology, Causes and Treatment of Puerperal Fever*, London, 1836.

[3] *A treatise on the epidemic puerperal fever as it prevailed in Edinburgh in 1821–22. To which is added an appendix, containing the essay of the late Dr. Gordon on the puerperal fever of Aberdeen in 1789, 1790, 1791, 1792.* Edinburgh, 1822.

[4] *A System of Midwifery*, London, 1841.

Strangely enough, Moore does not discuss Waller's contention, although he again mentions it in connection with the necessity for ventilation, cleanliness, and isolation of the patient in order to prevent extension of the disease. In this he says that

> "Dr. Waller's suggestion,[1] as to the probability of the infection being conveyed by contact with the genitals, is worthy of attention; as it accounts for the successive occurrence of the disease in a short time in the practice of one individual."

Moore also notes a curious experience reported by Jacques Lisfranc (1790–1847) at La Pitié to the effect that operative procedure on the uterus may excite uterine inflammation, which under certain circumstances exhibits many characteristics of puerperal fever. Lisfranc was one of the first to advocate amputation of the cervix and it was his experience that it was frequently followed by peritonitis and death. This induced Lisfranc to study the subject thoroughly and he found that the means which had been adopted of arresting the hemorrhage, namely, by a pack, caused the inflammation. He had since omitted the compression and permitted the blood and secretions to flow freely and recoveries had been rapid and numerous.[2]

Edward Rigby in his *System*, writing on the contagiousness of puerperal fever, says:

> "The contagious nature of puerperal fever has long since ceased to be a matter of doubt, and instances have repeatedly occurred of practitioners and nurses communicating the disease to several patients in succession. Dr. Gooch has recorded some striking instances of the kind, and we could enumerate many others if necessary. Where a practitioner has been engaged in the postmortem examination of a case of puerperal fever, we do not hesitate to declare it highly unsafe for him to attend a case of labour for some days afterwards. The peculiar smelling effluvia which arises from the body of a patient during life is quite, in our opinion, sufficient to infect the clothes; and every one who has made a minute dissection of the abdominal viscera, especially in fatal cases of puerperal fever, knows full well that it is almost impossible to remove the smell from the hands for many hours, even with the aid of repeated washing; it must be, therefore, self-evident, that, under such circumstances, it would be almost criminal to expose a lying-in patient to such a risk.
>
> "That the discharges from a patient under puerperal fever are in the highest degree contagious, we have abundant evidence in the history of lying-in hospitals. The puerperal abscesses are also contagious, and may be communicated to healthy lying-in women by washing with the same sponge: this fact has been repeatedly proved at the Vienna hospital; but they are equally communicable to women not pregnant; on more than one occasion the women engaged in washing the soiled bed linen of the General Lying-in Hospital have been attacked with abscesses in the fingers or hands, attended with rapidly spreading inflammation of the cellular tissue."

We must now leave for a period these eighteenth century and early nineteenth century obstetricians to consider briefly the evolution of the use of chlorine[3] as a disinfecting agent. Hydrochloric acid gas was employed by Guyton Morveau (1737–1816) in 1773 to disinfect the principal church of

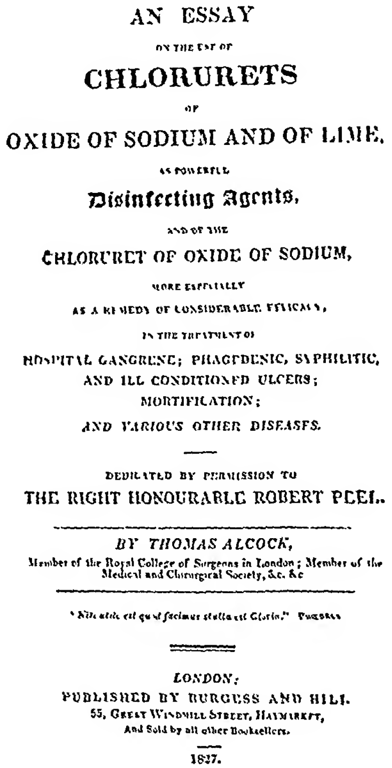
[1] "Dr. Waller's report on Midwifery, Medical and Physical Journal."

[2] *Lancet*, October 11, 1834.

[3] Chlorine was discovered by the Swedish chemist, Karl Wilhelm Scheele (1742–1786), in 1774. The French chemist, Claude Louis Berthollet (1748–1822), in 1785 described the bleaching qualities of chlorine, which suggestion was seized upon by English manufacturers and a commercial process was soon devised. Javel's solution was a step in this procedure. The most important suggestion, however, was made by Charles Tennant (1768–1838) of Glasgow, who prepared a bleaching powder which contained nearly one third of its weight of available chlorine.

physicians foul odors constituted infection, and the destruction of the odor destroyed the infection present in the air or on the substance with which the solution came into contact. Labarraque called his solution the chloruret of the oxide of sodium and of lime.[1] Following the approval of the French Council of Health in 1820, applications of Labarraque's solution were made in almost every known disease condition.

Thomas Alcock[2] (1784–1833), an English surgeon, visited Paris in 1823, and on every hand heard of the startling results in surgery achieved by the use of Labarraque's preparation of chlorine. Subsequent to his return to England, Alcock published in 1827 a manual on the medical use of chlorine



AN ESSAY

ON THE USE OF

CHLORURETS

OF

OXIDE OF SODIUM AND OF LIME,

AS POWERFUL

Disinfecting Agents,

AND OF THE

CHLORURET OF OXIDE OF SODIUM,

MORE ESPECIALLY

AS A REMEDY OF CONSIDERABLE EFFICACY,

IN THE TREATMENT OF

HOSPITAL GANGRENE; PHAGEDENIC, SYPHILITIC, AND ILL CONDITIONED ULCERS; MORTIFICATION;

AND VARIOUS OTHER DISEASES.

DEDICATED BY PERMISSION TO

THE RIGHT HONOURABLE ROBERT PEEL.

BY THOMAS ALCOCK,

Member of the Royal College of Surgeons in London; Member of the Medical and Chirurgical Society, &c. &c

"Nisi utile est quod facimus stulta est Gloria." PHAEDRUS.

LONDON:

PUBLISHED BY BURGESS AND HILL.

55, Great Windmill Street, Haymarket,

And Sold by all other Booksellers.

1827.

Fig. 53.—Facsimile of the title page of *An Essay on the Use of Chlorurets of Oxide of Sodium and of Lime* by Thomas Alcock, London, 1827.

entitled *An Essay on the Use of Chlorurets of Oxide of Sodium and of Lime, as powerful Disinfecting Agents*, etc. (Fig. 53). This manual sets forth the several uses of the solution in combating disease and in promoting healthful conditions. He quotes Labarraque as follows:

[1] *De l'emploi des chlorures d'oxide de sodium et de chaux*, Paris, 1825.

[2] Thomas Alcock, surgeon, was born at Rothbury, Northumberland. After an apprenticeship to a surgeon in Newcastle, in 1804 he became resident medical officer at the Sunderland Dispensary. In 1806 or 1807 he moved to London and became a general practitioner. After 1825 he devoted himself to surgery and was surgeon to St. James's Workhouse from 1813 to 1828. A course of *Lectures on Practical and Medical Surgery*, delivered to the students of the Borough Dispensary, appeared in the *Lancet* in 1825–1826, and was published with additions in 1830. He contributed many papers to medical journals.

There seems to be little doubt that many medical uses for Labarraque's solution were readily found. The Bulletin of the Commission of Health of Marseilles for 1825 concerning the care of the sick and the sick room contains, among others, the following paragraphs:

"1. Washings and aspersions with chloruretеd water to be made in the wards several times every day.

"2. Tubs containing chlorureted water are to be placed in the same wards, so as to keep up a continual evaporation of the chlorurets.

"3. The physicians, almoners, servants and all those who take care of the sick, before appoaching them, and on quitting them, to *wash their hands with chlorureted water.*"

The use of chlorureted baths for the patients and medical attendants is suggested as a proper precautionary measure in dealing with contagious diseases.

The *Medico-Chirurgical Review*[1] in reviewing James Scott's translation[2] of Labarraque's work on the use of the chloruret of soda and of lime, and the essay of Thomas Alcock previously mentioned, says:

"But once for all, we object to the coupling of the words, purification and disinfection. Bad smells may be corrected, and contagion may still remain. We have always upheld the doctrine, that ventilation is the best and safest disinfectant. To remove the infected air, is surely more effectual than to correct or cover a fetid exhalation floating in it, since we cannot tell what the contagious miasm is, or whether it really has any fetid odor or not."

The reviewer closes with this statement:

"We think that enough has been adduced that the chlorurets of lime and soda possess strong powers of destroying the fetor of various disagreeable and noxious substances—but how far they will be capable of annihilating the contagious or infectious miasms of certain exhalations from animal or vegetable matters, this deponent saith not."

The use of chlorine in preventing or destroying disease processes is frequently mentioned in the current literature beginning about 1820. Among the books on the subject is that of William Wallace[3] (1791–1837) entitled *Researches Respecting the Medical Power of Chlorine*, etc., London, 1822. Numerous references are found in the *Lancet*, the *Medico-Chirurgical Review*, *Archives Générales de Médecine*, *Journal de Médecine*, *Dublin Quarterly Journal*, *Edinburgh Medical Commentaries*, *Edinburgh Medical and Surgical Journal*, the *American Journal of the Medical Science*, *Schmidt's Jahrbücher*, etc. It was not until 1884, however, that a thoroughly scientific and quantitative evaluation of the power of chlorine as a bactericidal agent was made by Bernhard Fisher (1852–1915) and Bernhard Proskauer[4] (1851–1915). The occasion of the World War witnessed the widespread use of what is practically Labarraque's solution under the name "Carrel-Dakin"[5] solution. Milton Joseph Rosenau

[1] London, 1827.

[2] *The use of the chlorate of soda and the chlorate of lime.* London, 1826.

[3] William Wallace was the first to advocate the use of potassium iodide in the treatment of tertiary lues.

[4] *Ueber die Desinfection mit chlor und Brom, Mittheilungen aus dem Kaiserlichen Gesundheitsamte*, vol. ii, Berlin, 1884.

[5] Carrel-Dakin solution was the result of study by Henry Drysdale Dakin and Alexis Carrel in search of the ideal wound antiseptic. Dakin believed that the antiseptic power of the solution *in vivo* is due to the formation of a chloramine by the combination of the slowly liberated chlorine and the tissue proteins. A modification of this solution, proposed by Dufresne, is now commonly used and is embodied in the U. S. Pharmacopoeia as Liquor Sodae Chlorinatae Chirurgicalis. The Carrel-Dakin treatment consists in flooding the

of the hospital, Collins was twenty-six years of age, having graduated in medicine from Glasgow in 1822. He succeeded Pentland, who had died in office after a service of not quite five years. Although Collins' mastership expired in November, 1833, he did not publish his report[1] (Fig. 56) until 1835. This work impresses the reader with the author's absolute sincerity and honesty. The style is clear and precise. The statistical tables are examples of painstaking care and the author is utterly frank in acknowledging mistakes. The most startling pronouncement is that in which he relates his experiences with *chlorine disinfection.* When Joseph Clarke was master he had given the

Fig. 55.—Robert Collins. (From the author's collection.)

hospital a thorough cleaning on the first appearance of puerperal fever, having recourse to "the expensive and troublesome process of painting, etc.," and "every symptom of fever subsided as the patients were received into clean wards." Describing the cleanliness exercised by Labatt in one of the earlier epidemics during his mastership, Collins says:

> "In the epidemic of 1819 and 20, the most scupulous and unwearied attention was paid to cleanliness, ventilation, etc. by Doctor Labatt, who was then Master; every effort, however, was insufficient to check the disease for a considerable time. In one instance a ward, in which there had not been any patients for several months, and which had been in the meantime kept strictly clean and well aired, was opened, and five patients admitted, *three* of whom were seized with the fever, and two died."

[1] *A Practical Treatise on Midwifery, containing the result of Sixteen Thousand six hundred and fifty-four Births, occurring in the Dublin Lying-In Hospital, during a period of seven years, commencing November, 1826.* London, 1835.

ward was washed every ten or twelve days, the solution being left on for twenty-four hours, during which time the blankets, quilts, linen, etc., were suspended, so as to be exposed completely to the chlorine gas, which is copiously disengaged from the preparation mentioned. The chloride of lime was then carefully washed off, and the boards when dry, polished with a brush. It may appear strange that a process, such as stated, should be considered advisable in an establishment which is at *all times* kept in the most perfect state of *neatness* and *cleanliness*, in every respect; so much so, that few private houses would bear comparison; yet the result consequent on such a practice will fully justify our having had recourse to it. To the ventilation of the Hospital, I always paid the most strict attention, so that no heated or vitiated air might be suffered to accumulate. In addition to the air tubes, etc., I had from one inch and a half to two inches of the upper sash of the window most remote from the patient's bed, kept open day and night throughout the entire year, except during extreme cold at night in the winter, thereby ensuring a free circulation of pure air.

"All the beds in the Hospital are composed of straw, nor is any one used more than a second time without the cover having been washed and the straw renewed. In every instance where the patient *dies*, this is at once done, and should the most remote symptom of *fever* have been present, every article connected with the bedding is instantly scoured and stoved; the wood-work and floor washed with the chloride of lime solution, and the entire ward whitewashed. This is readily effected, as the sick are invariably placed in a small ward, apart from the healthy. To this precaution too much attention cannot be paid; I am satisfied the *instant* separation is of vast importance to both.

"I have thus minutely described the measures adopted to banish or guard against this disease during my residence, the consequences of which were extremely satisfactory. Of 10,785 patients delivered in the Hospital subsequent to this period, only 58 died (from all causes), which is nearly in the proportion of *one* in every *one hundred and eighty-six;* the lowest mortality perhaps on record, *in an equal number* of a *similar class of females.*"

One is tempted to indulge in a laudatory commentary on the experiences of Robert Collins. The above quotation, however, is complete and requires no ancillary proof. Collins nowhere mentions the washing of the obstetrician's hands with chlorinated water. He must have perused Alcock's book, that of William Wallace, or possibly the original work of Labarraque. Alcock repeatedly advised washing the hands in diluted Labarraque's solution. The fact remains, however, that Collins delivered 10,785 women without one death from what was then recognized as puerperal fever and with a maternal mortality from all causes of 0.53 of 1 per cent.[1]

William J. Sinclair in his life of Semmelweis[2] appears to be in error in attributing the use of chlorine to Labatt in the Dublin Rotunda in 1819–1820. Sinclair says that in Labatt's hands with

". . . fumigation of the hospital with chlorine gas and washing with solution of chloride of lime . . . of 171 patients admitted in the month of January, 1820, sixty-three were attacked with puerperal fever and twenty-five died."

No record can be found to indicate that Labatt used chlorine gas, chloride of lime, or any other preparation of chlorine. He did his best to clean the wards thoroughly, and employed scrubbing, whitewashing, and painting.

Most writers on Dublin midwifery seem to have missed the principal point made by Collins, namely, that chlorine used in the manner which he describes changed the picture from puerperal fever with a certain amount of cleanliness under the mastership of Labatt to no puerperal fever with cleanliness plus chlorine during the last four years of Collins' mastership. After his retirement as master, no further use of chlorine is recorded and in

[1] During two of the years of Robert Collins' mastership the maternal mortality (from all causes) fell to 4/10 of 1 per cent.

[2] Loc. cit.

Through the assistance of Dr. John Roberton (1797–1876), one of the surgeons of the Manchester Lying-in Hospital, Henry was supplied with fresh vaccine lymph "taken from pustules of unequivocable character." This material Henry subjected to heat for periods of two to four hours after which healthy children were inoculated. As a result he showed that vaccine lymph heated for a period of from two to four hours at a temperature not below 130 F. was rendered inert. Three experiments of this character are recorded, all with the same result.

A second series of experiments was undertaken with the cooperation of Mr. William Marsden (1796–1867), house surgeon of the Manchester Royal Infirmary, and specimens of vaccine lymph heated for two hours at 150 F., four hours at 150 F., two hours at 172 F., four hours at 172 F., all proved inert. Lower temperatures were then tried and it was found that a temperature of 120 F. continued for three hours did not decrease the virulence of the vaccine lymph.

Henry then constructed a chamber made of copper consisting of an inner and outer shell, the space between the shells so arranged that steam could be admitted. Stopcocks were provided for the discharge of condensation, and the escape of surplus steam. This apparatus he recommended for the sterilization of all articles known to have been in contact with patients ill with contagious disease. Concluding his article he says that he does not propose to supersede the employment of chemical disinfectants, particularly that of chlorine.

A subsequent article[1] by William Henry sets forth his experiments with typhus and scarlatina. In the first disease, clothing that had been in contact with a patient was exposed to a temperature slightly in excess of 200 F. for one hour and three quarters, and was thereafter worn next the body of a healthy individual for two hours without injurious effect.[2] In scarlatina, a disease which Henry says "no one doubts of its being infectious," clothing worn next the body of acutely ill patients was heated four and one-half hours at 204 F. and shortly thereafter was worn by a boy (age six years) for a period of one week with no appearance of the disease. Articles of clothing from other acutely ill cases of scarlatina, that had been heated at a temperature of from 200 to 204 F. for a period of two and three-quarter hours, were worn by the same volunteer who remained perfectly well. In all, four different volunteers remained perfectly well subsequent to wearing sterilized clothing that had been in contact with acutely ill scarlet fever cases.

From this Henry concluded that

> ". . . by exposure to a temperature not below 200° F. during at least one hour the contagious material of scarlatina is either dissipated or destroyed."

Again he says:

> "I think it demonstrable that the disinfecting agency belongs to heat alone."

To this article he appends an illustration with a description of his apparatus.

[1] *Further experiments on the disinfecting powers of increased temperatures. Philosophical Magazine*, vol. xi, 1832, pp. 22–31.

[2] Probably the earliest instance of delousing.

Fieber und die Kindbett-Fieber (1837) (Fig. 58)—deserve attention inasmuch as from *a priori* reasoning based on extensive perusal of the literature, Eisenmann approached very closely to the true etiology and prophylaxis of puerperal fever. Both works are marvels of theoretical deduction and were written while he was in prison. At the time Eisenmann had had comparatively little clinical experience.

Eisenmann was a man of exceptional mentality. At the age of fifteen he began the study of law which was interrupted three years later when he entered military service. In 1815 he changed his plans abruptly and entered upon the study of medicine. He received his degree in 1818 and located at

Die

Wund-Fieber

und die

Kindbett-Fieber.

Beschrieben

von

Dr. Eisenmann.

Erlangen, 1837

bey J. J. Palm und Ernst Enke.

Fig. 58.—Facsimile of the title page of *Die Wund-Fieber und die Kindbett-Fieber* by Gottfried E. Eisenmann, Erlangen, 1837.

Würzburg in 1822. Within a year thereafter, because of his political activities, he was arrested and imprisoned for a period of two years. He later turned his attention to practical politics and in 1828 published a political journal. For a time he was in the good graces of the authorities. With the political upheaval of 1832, however, his paper was suppressed and he was convicted and sentenced to prison for a term of fifteen years. During this period of incarceration he prepared several monographs on medical subjects. In his prophylactic régime (*Die Kindbett-Fieber*), Eisenmann recommends the use of powdered chlorinated lime with phosphoric acid. The action of bacteria, had Eisenmann known about bacteria, is very well described in the following lines:

peral fever. One can well understand the consternation that must have filled the minds of this small group of earnest students of medicine on hearing the reports of cases that led irresistibly to the conclusion that puerperal fever could be conveyed from the sick to the well.

One of the early significant reports at the meeting of September, 1842, was that of Dr. Enoch Hale[1] (1790–1848). He had seen a young Irish immigrant girl on Wednesday evening, who the day before had complained of an acute sore throat. There was some redness of the skin and on the following day, a doubtful scarlet eruption which on Thursday proved to be an erysipelas of the face. She had not menstruated since April and on Friday night a fetus near full term was born. Shortly after the delivery, the mother became acutely ill and died.

Fig. 59.—Oliver Wendell Holmes. (From the author's collection.)

The next incident occurred early in October, 1842, and the minutes record that Dr. John D. Fisher[2] (1797–1850) reported that a Dr. Whitney of Newton, with two of his students, had performed a postmortem upon the body of a woman who had succumbed to puerperal fever:

"Dr. Whitney had upon one of his fingers a hang nail, which had not been troublesome, but which he found to be bleeding after the examination. The examination was made on Friday. On Saturday, Dr. Whitney came to Boston. As he was going home in the cars, he felt very chilly, and in the night became quite feverish. Sunday morning, however, he attended to his business, and was at church in the afternoon. Sunday night he was more feverish, and took a dose of physic. Monday morning he was quite faint on going down stairs, and then first observed an unpleasant sensation in his hand. When washing he

[1] Dr. Enoch Hale with Drs. John Collins Warren and George Hayward (1791–1863) organized a private medical school which had a successful existence of eight years.

[2] John Dix Fisher, M. D., Harvard Medical School, 1825; founder of and physician to the Perkins Institution for the Blind, Boston.

was called in consultation, and advised quinine. In spite of all that could be done her death followed. The right broad ligament and tube were found to be greatly swollen and full of a cheesy matter-like tubercle.

At the same meeting Dr. John Barnard Swett Jackson[1] (1806–1879) reported a death following a dissection wound:

> "Dr. Barker of Lynn made an examination of a case of puerperal fever last Monday evening. He had at the time several open sores on each hand, and pricked himself while sewing up the body. On Tuesday he was not very well but was out. He was out also on Wednesday morning, but most of the day kept on the sofa. He had a rigor on Tuesday and also on Wednesday followed by intense heat. On Thursday Dr. Jackson was sent for to see him. He had had no sleep that night, very ardent thirst, complained of pain about the shoulder, but had no affection of the axilla or of the absorbents. There was considerable swelling of the shoulder, and some redness which was probably produced by the local applications. There were however red spots about the clavicle which could not have been owing to them. His pulse had been 120, was then 108. The pain in the head back and limbs was not severe. He had taken cathartics of senna and of calomel and julep which had operated freely. As he was a very strong athletic man Dr. Jackson advised bleeding from the arm, and if no relief by night leeches to the shoulder. He was bled 18 ounces and at night had the leeches applied. His pulse immediately failed after the bleeding. The shoulder after the application of the leeches became easier, but pain then came on in the left side about the short ribs, and he had 7 or 9 leeches applied here. On Saturday his friends sent up word that he was not so well, and in the afternoon Dr. Jackson again saw him with Dr. (Abel L.) Peirson of Salem. He had failed much. His skin was damp and inactive. There had been some wandering. He was put upon calomel and opiates. He had since heard that he continued to sink, and that on Sunday he was put upon stimulants. He died at 6 o'clock last evening."

At the meeting held on January 23, 1843, Dr. Jackson stated that a post-mortem had been made on Dr. Barker of Lynn and that a full report would be made at a later meeting. In the minutes of this meeting occurs this significant paragraph:

> "Dr. John Jackson asked the opinion of the Society as to the contagion of Puerperal Fever, and the probability of Physicians communicating it from one patient to another.
>
> "An animated discussion followed, and on motion of Dr. Jackson it was voted that it be continued at the next meeting."

This discussion made it clear to Holmes that a fuller knowledge of the facts relating to the subject was much needed, and he therefore felt that it would be doing a good service "to learn what experience had to teach in the matter."

At the ensuing meeting held February 13, 1843, the minutes record that "Dr. Holmes read a paper on the contagion of Puerperal Fever." There was no discussion. One can well imagine the awed silence with which the paper ended, and Dr. Jackson's motion that "Dr. Holmes be requested to publish the paper which he has just read," was all that could be said.

Evidently Holmes' paper was the principal subject of discussion as the members of the Boston society met their colleagues during the weeks that followed and this discussion was carried over into the following meeting of the society. Comparatively little is recorded in the minutes of this meeting, other than reports of cases of puerperal fever. Dr. Channing reported that he had attended a woman in confinement at Charleston who had a febrile

[1] John Barnard Swett Jackson, pioneer pathologist, was professor of pathologic anatomy at Harvard Medical School from 1854 to 1879. His most valuable contribution to the medical profession is "The Warren Anatomical Museum."

but were more forcefully stated, more definite and more accurate. Had Holmes' rules been followed to the letter by practitioners of midwifery the world over, the incidence of puerperal fever would have been tremendously reduced. Holmes cites the suggestive experience of one of his correspondents who during an epidemic of puerperal fever in his practice changed his clothes and washed his hands in chloride of lime after each visit. He then attended seven women in labor during this period, none of whom was ill.

The career of Oliver Wendell Holmes is so familiar as to require no detailed narration. His natural predilection for literature and his teaching

Contagiousness of Puerperal Fever. 503

ART. V.—*The Contagiousness of Puerperal Fever.* Read before the Boston Society for Medical Improvement, by OLIVER W. HOLMES, M.D., and published by request of the Society.

In collecting, enforcing and adding to the evidence accumulated upon this most serious subject, I would not be understood to imply that there exists a doubt in the mind of any well-informed member of the medical profession as to the fact that puerperal fever is sometimes communicated from one person to another, both directly and indirectly. In the present state of our knowledge upon this point I should consider such doubts merely as a proof that the sceptic had either not examined the evidence, or, having examined it, refused to accept its plain and unavoidable consequences. I should be sorry to think with Dr. Rigby, that it was a case of "oblique vision;" I should be unwilling to force home the *argumentum ad hominem* of Dr. Blundell, but I would not consent to make a *question* of a momentous fact, which is no longer to be considered as a subject for trivial discussions, but to be acted upon with silent promptitude. It signifies nothing that wise and experienced practitioners have sometimes doubted the reality of the danger in question; no man has the right to doubt it any longer. No negative facts, no opposing opinions, be they what they may or whose they may, can form any answer to the series of cases now within the reach of all who choose to explore the records of medical science.

If there are some who conceive that any important end would be answered by recording such opinions, or by collecting the history of all the cases they could find in which no evidence of the influence of contagion existed, I believe they are in error. Suppose a few writers of authority can be found to profess a disbelief in contagion—and they are very few compared with those who think differently—is it quite clear that they formed their opinions on a view of all the facts, or is it not apparent that they relied mostly on their own solitary experience? Still further, of those whose names are quoted, is it not true that scarcely a single one could by any possibility have known the half or the tenth of the facts bearing on the subject which have reached such a frightful amount within the last few years? Again, as to the utility of negative facts, as we may briefly call them,—instances, namely, in which exposure has not been followed by disease,—although, like other truths, they may be worth knowing, I do not

Fig. 60.—Facsimile of first page of article by Oliver Wendell Holmes in *New England Quart. Jour. Med. and Surg.*, 1843, vol. i, p. 503.

fully occupied his time and at a comparatively early date he relinquished active practice. With the establishment of the *Atlantic Monthly* came the *Autocrat of the Breakfast Table* papers, and Holmes' position in world literature was established. Although hailed throughout America as a great poet and essayist, Holmes held a lurking pride of accomplishment in his puerperal fever essay. In a letter addressed to his friend, Dr. James R. Chadwick (1844–1905), librarian of the Boston Medical Library, Holmes writes under date of May 8, 1883:

"It is just fifty years since my essay on the contagiousness of puerperal fever was published in the *New England Journal of Medicine and Surgery*. It had been previously

"The result of the whole discussion will, I trust, serve not only to exalt your views of the value and dignity of our profession, but to divest your minds of the overpowering dread that you can ever become, especially to women under the extremely interesting circumstances of gestation and parturition, the minister of evil; that you can ever convey, in any possible manner, a horrible virus so destructive in its effects and so mysterious in its operations as that attributed to puerperal fever."

For many years following 1843, American medical writers published numerous papers on the contagiousness of puerperal fever and ample evidence was supplied through case citations, to support Holmes' position.

In an article read before the Sheffield Medical and Surgical Society[1] Robert Storrs, of Doncaster, maintained that

". . . puerperal fever once set up is again capable of imparting to many persons not in the puerperal state by actual contact or close approximation, the following diseases.

"1s. Inflammation of the peritoneum or other serous membranes, accompanied by low fever, both in the male and female subject.

"2d. Erysipelas; local, as in the hand or arm, from *postmortem* inspections; or general, as in the face or person.

"3d. Typhus fever, with its various accompaniments, and in a variety of forms."

In support of the above conclusions numerous clinical cases are cited, most of which are from his own practice. The position of Dr. Storrs was supported in a later article by Dr. James Reid[2] in which he cites a fatal case of erysipelas in the husband of a woman ill with puerperal fever. It appears that the husband had occupied the same bed with the wife.

Samuel Kneeland[3] (1821–1888) in his article, *On the Connection between Puerperal Fever and Epidemic Erysipelas, in its origin and mode of propagation*[4] notes that erysipelas frequently attacks a patient where there has been a break in the skin: "a solution of continuity." He describes the observations of the French obstetrician, Paul Dubois[5] (1795–1871) who found, on making a careful examination of the vulva, vagina, and cervix following delivery, small rents and lacerations, the mucous membrane being almost always more or less detached, "the neck of the uterus soft, flaccid and torn to a considerable extent." He says:

"This condition is so universal, that there is no surer criterion by which to judge that a woman has had children, than by the cicatrices of these little wounds."

Kneeland calls attention to the fact that a wound is frequently present after delivery and says

". . . you have exciting causes enough to call forth the latent poison of erysipelas."

[1] Published in the *Provincial Medical and Surgical Journal*, May 7, 1845.

[2] *London Medical Gazette*, 1845.

[3] Samuel Kneeland received his M. D. from Harvard Medical School in 1843. After two years of medical study in Paris, he began the practice of medicine in Boston. In 1846 he was awarded the Boylston prize for his essay *On the Contagiousness of Puerperal Fever.* Following his service as a surgeon during the Civil War he became professor of zoology and secretary of the Massachusetts Institute of Technology.

[4] *American Journal of the Medical Sciences*, n. s., vol. xi, 1846.

[5] Paul Dubois greatly advanced the science of obstetrical auscultation. In 1825 he was made professor and surgeon-midwife to the Paris Maternité. He published *La fièvre puerpérale de la Maternité*, 1841, *Lancette française*, Nr. 85; and *Discours prononcés à l'Académie impériale de médecine, dans la discussion sur la fièvre puerpérale*, Paris, 1858.

"Day and night the vision of Kolletschka's malady haunted me, and with ever increasing conviction I recognized the identity of the disease from which Kolletschka died with the malady which I had observed to carry off so many lying-in women."

Semmelweis had no doubt noted on many occasions the foul odor clinging to the hands of students coming to the lying-in wards from the dissecting rooms. Kolletschka's wound occurred while he was dissecting a cadaver and Semmelweis immediately coupled the (cadaveric) poison which destroyed Kolletschka with the cadaveric odor on the hands of his students who made vaginal examinations in the lying-in wards.

"In order to destroy the cadaveric material which adheres to the hands, I began about the middle of May, 1847, to employ chlorida liquida with which every student was required to wash his hands before making an examination. Later a solution of chlorinated lime was substituted because it was not so expensive. . . . The experience of every month went to support the belief that puerperal fever was nothing more nor less than cadaveric blood poisoning . . . all appeared to justify the conviction that the hitherto unknown endemic cause of the frightful devastation which puerperal fever had wrought in the First Clinic[1] had at last been discovered; it was simply the cadaveric material adhering to the examining hands in the First Clinic."

We may now note the gradual evolution of the etiology of puerperal fever in the experience of Semmelweis. Early in the summer of 1847 he announced his Lehre as follows:

Lehre I. Puerperal fever is caused by the conveyance to the pregnant woman of cadaveric particles through the agency of the examining finger.

This was the position to which Semmelweis held steadfastly until there occurred two sequential outbreaks of puerperal fever, each of which required a different explanation. The first occurred in October, 1847, and was attributed to a woman suffering from a foul-smelling cancer of the cervix; the second, which began in November, was attributed to a woman suffering from caries of the knee joint. Students through examining the cancer patient conveyed putrid particles to other women and puerperal fever was the result. Semmelweis says:

"After examining this patient (the case with a cervical cancer) we all washed our hands merely with soap and water: the consequence of these proceedings was that of twelve women confined at the same time eleven died of puerperal fever. From this experience the inference had to be drawn that not only cadaveric particles adhering to the hands but putrid material derived from the living organism, produced the disease. Consequently it was necessary that the examining hands not only after manipulating the cadaver, but even after examination of individuals from whom putrid material might render foul the hands, must also be disinfected by chlorine before another patient is examined."

By November, Semmelweis added to his Lehre:

Lehre II. Puerperal fever may be caused by the conveyance to the pregnant woman of putrid particles derived from living organisms through the agency of the examining finger.

[1] Teaching of medical students was conducted in the First Clinic; of midwives only in the Second Clinic. The students came from the anatomical rooms to the First Clinic. Prior to Semmelweis' use of chlorine the mortality in the First Clinic was as high as 9.9 per cent. In the Second Clinic the mortality remained low.

sioned by the first Lehre of Semmelweis which naturally emphasized cadaveric poison. Obstetricians elsewhere could see in the experience of Semmelweis no similarity to their own practice, inasmuch as neither they nor their students went directly from the dissecting rooms to the lying-in wards. Hebra's original article was followed in the same journal with a second article which appeared in 1849. In this he stated that he considers the discovery of Semmelweis as ranking with that of Edward Jenner (1749–1823). It is interesting to note that the insistent urging of Josef Skoda (1805–1881) that Semmelweis engage in animal experimentation to prove his Lehre was without avail, and Sinclair notes that even after funds had been voted for the purpose, Semmelweis declined to carry on animal experimentation on the ground that the clinical evidence was sufficient to establish the truth of his position. While Semmelweis had many friends, his Lehre, as might have been expected, was bitterly opposed, particularly by Friedrich Wilhelm Scanzoni (1821–1891), Carl Braun (1822–1891) and his "Open Letters," the first of which was entitled *Two Open Letters to Dr. J. Späth, Professor of Midwifery at the Joseph's Academy in Vienna, and to Hofrath Dr. R. W. Scanzoni, Professor of Midwifery at Würzburg*, dated Buda-Pesth, 1861, contained much controversial material.[1]

Because of disappointment and no doubt disgusted with what must have seemed to Semmelweis as ungrateful opposition, he determined to leave Vienna. He had petitioned more than once for University recognition as a *Privat-Dozent* and although appointed in October, 1850, his activities were restricted to theoretical teaching. Deprived of any further opportunity for clinical work in Vienna, Semmelweis determined to return to his native city Pesth, where early in 1851 he was given charge of the obstetrical division of St. Rochus Hospital. He promptly introduced chlorine disinfection and his mortality at St. Rochus between 1851 and 1856 from puerperal fever was 0.85 of 1 per cent. On the death of Professor Birly in 1855 he was appointed professor of midwifery. In 1856–1857 he lost 16 patients from puerperal fever. Here he discovered for the first time the importance of clean linen and clean dressings. This mortality was a blow to his "Übertragung" and he found that the sheets of the beds "actually stunk with decomposed blood and lochia." Here was no "carrying over," no conveyance of infection by the examining finger. In the year 1857–1858 of 449 confinements, 18 died of puerperal fever, a mortality of 4 per cent. Again he found that the bed linen was not changed with sufficient frequency and that the sheets were foul. Early in 1858, 10 women died in one day of puerperal fever and all this time chlorine disinfection of the examining hand was scrupulously enforced.

In the autumn of 1857 Semmelweis decided to publish his *Die Aetiologie* (Fig. 62) and four years later the book appeared, constituting one of the landmarks in the progress of midwifery. The *Aetiologie* contains a number of additions to his original Lehre. Because of his experience in Pesth he had added a fourth Lehre:

> Lehre IV. Puerperal fever may be conveyed to the lying-in woman by the foul bedclothes, dressings, and sponges, and by the hands of midwives and nurses.

[1] The second letter was addressed to Professor Siebold of Göttingen and Professor Scanzoni of Würzburg.

phase. The cells are narrow, closely placed, and, after the first day or so, of uniform height.

2. In the interval phase, the epithelium is uniformly tall, the ciliated cells being broad, with rounded nuclei near the free margin, while the non-ciliated cells are rather narrower, the nuclei being more deeply placed and taking a deeper stain.

3. In the premenstrual phase the ciliated cells become lower, so that the "secretory" cells project beyond them, giving the epithelial margin a

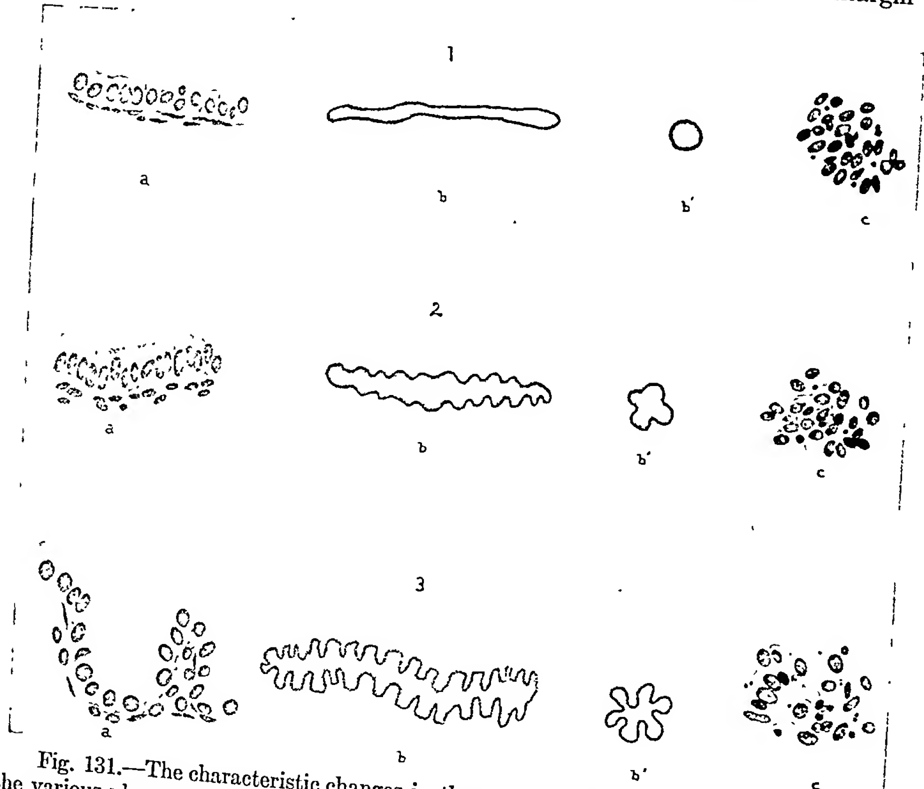


Fig. 131.—The characteristic changes in the uterine epithelium, glands and stroma at the various phases of the menstrual cycle. 1, The postmenstrual stage: (a) Epithelium; (b) gland in longitudinal section; (b') gland in cross section; (c) stroma. 2, The interval stage: (a) Epithelium; (b) gland in longitudinal section; (b') gland in cross section; (c) stroma. 3, The premenstrual stage: (a) Epithelium; (b) gland in longitudinal section; (b') gland in cross section; (c) stroma. N. B. The menstrual stage is not illustrated, as it represents a transition from (3) to (1). (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

ragged, uneven appearance. The "secretory" cells show a bulbous herniation into the lumen of the tube, often carrying the nucleus with it. This extrusion of nuclei is similar to that seen in many lower animals, but its significance is not known. In spite of the great loss of cells, mitoses are rarely seen in the tubal epithelium.

4. During the stage of menstruation, the premenstrual changes are carried further, the epithelium becoming quite low. The ciliated cells, especially, remain broad and low, but the secretory cells also, having been

Ruth Barnaby (1664–1765), Margaret Jones (d. 1648) and Elizabeth Phillips (1685–1761). Mrs. Fuller, the first midwife in the Massachusetts Bay Colony, was the wife of Dr. Samuel Fuller. Subsequent to her husband's death (1633) she practiced as a midwife and the town records of Rehoboth for July 3, 1663, record that

". . . Mrs. Fuller of Plymouth be invited to come and dwell among us to attend on the office of midwife to answer the town's necessity which at present is great."

Anne Hutchinson settled with her husband in Boston in 1634 but because of her religious fanaticism was exiled to Rhode Island where she was killed by Indians. Ruth Barnaby of Boston practiced as a midwife for more than forty years. Packard[1] notes that in her one hundredth year she insisted upon being inoculated against smallpox. Margaret Jones of Charlestown was executed as a witch. Elizabeth Phillips, wife of John Phillips, was born in London (Westminster) and was licensed as a midwife by the Lord Bishop of London in 1718. She came to Boston in 1719 and practiced midwifery for more than forty years. On her tombstone is inscribed

". . . by the blessing of God brought into this world above 3000 children."

In the history of the colonies only occasional mention is found of the assistance of male physicians in childbirth. When a physician was called it was usually in the capacity of a surgeon for the purpose of dismembering an impacted fetus. The earliest colonial practitioner to specialize in midwifery was John Moultrie (d. 1775), who emigrated to Charleston some time prior to 1729 from Culross, Fife, Scotland.[2] Moultrie probably practiced medicine in Charleston for several years prior to 1749, in which year he was graduated from the University of Edinburgh,[3] after defending a thesis entitled, *De Febre maligna biliosa Americae.*[4] A careful search fails to reveal evidence either of John Moultrie's special training in midwifery or of his private teaching of this subject. He acquired, however, a wide reputation in Charleston and vicinity as a practitioner of midwifery. Thacher[5] notes that Moultrie was particularly skilled in obstetrics and that his death was regarded as a public calamity. Following the plan of training physicians then in vogue in the colonies, Moultrie no doubt accepted private pupils.[6]

[1] *History of Medicine in the United States.* By Francis R. Packard. New York, 1931.

[2] A son, William Moultrie, was born in Charleston on November 23, 1730. He espoused the cause of American independence and served with distinction in the southern department of the continental army. For his defense of Sullivan's Island off Charleston, he was voted the thanks of Congress and made a brigadier-gen[illegible]. On the surrender of Charleston to the British (1780), he was imprisoned until February, 1782, when he was exchanged with others for General Burgoyne. He was governor of South Carolina, 1785–1787 and 1792–1794.

[3] David Ramsay, M. D., in his *The History of South Carolina* (Charleston, 1809) infers that Moultrie was a native South Carolinian and Garrison in his *Introduction to the History of Medicine* (Philadelphia, 1917) refers to Moultrie as the first American to graduate from the University of Edinburgh.

[4] Recorded in the *List of the Graduates in Medicine in the University of Edinburgh* for the year 1749. Edinburgh, 1867.

[5] *American Medical Biography.* By James Thacher. Boston, 1828.

[6] At a somewhat later period William Charles Wells (1757–1817) was apprenticed to a distinguished South Carolina physician, Alexander Garden (1728–1792). Wells was born in Charleston and became one of the most acute clinical observers of the English school in the late years of the eighteenth century. His *Essay on Dew* (1814) was awarded the Rumford medal.

James Lloyd (1728–1810) (Fig. 63) served his preliminary apprenticeship in medicine under William Clark of Boston. At the age of twenty-two he visited London where he spent two years as dresser to Joseph Warner[1] (1717–1801), one of the surgeons of Guy's Hospital. He attended the anatomical lectures of William Hunter as well as the midwifery lectures of William Smellie. He returned to Boston in 1750 and after a short period of general practice devoted himself exclusively to midwifery. He soon became known as the best-trained surgeon and obstetrician of Boston and vicinity, and was much sought for as a preceptor by ambitious students. It is definitely known that he accepted many students[2] and there is some evidence to indicate that between

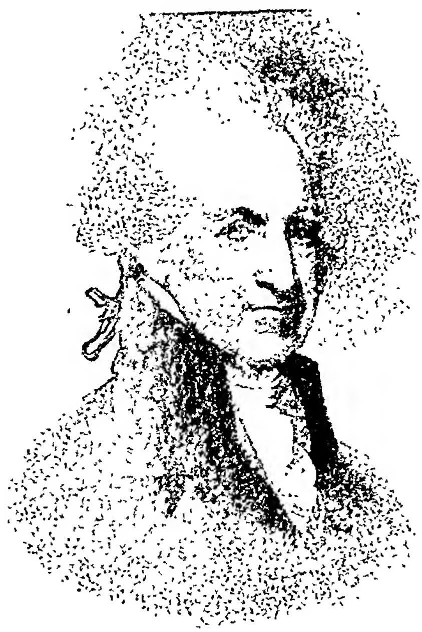


Fig. 63.—James Lloyd. Portrait from *A History of the Massachusetts Medical Society* by Walter L. Burrage, Norwood, Mass., 1923.

1752 and 1755 he delivered a series of lectures to his students and to members of the profession. He was one of the early councilors of the Massachusetts Medical Society and an honorary member of the American Philosophical Society. Harvard University conferred upon him in 1790 the honorary degree of Doctor of Medicine. According to Joseph Meredith Toner[3] (1825–

[1] Joseph Warner was surgeon of Guy's Hospital, 1746–1780, and the leading physician of London; fellow of the Royal Society.

[2] Among Lloyd's pupils who achieved distinction were Isaac Rand (1743–1822), John Jeffries (1745–1819) and Oliver Prescott (1731–1804). Rand acquired an extensive practice in midwifery. Jeffries subsequently studied midwifery with Colin Mackenzie (who will be remembered as the teacher of William Perfect) in London and received his M. D. from the University of Aberdeen. He was a surgeon in the British Army during the American Revolution. In 1790 he located in Boston and specialized in midwifery, leaving a record of 2000 cases of labor. Prescott was one of the first physicians to suggest the use of ergot in midwifery.

[3] *Address on Medical Biography* delivered before the International Medical Congress, Philadelphia, 1876.

began a course of lectures on anatomy with dissections at his father's house. These lectures were continued during the winter of 1762–1763. The published announcement of his anatomical lectures is dated November 11, 1762, and contains the statement that

> ". . . . all the necessary operations in surgery will be performed, a course of bandages exhibited, and the whole conclude with an explanation of some of the curious phenomena that arise from an examination of the gravid uterus, and a few plain general directions in the study and practice of midwifery."

The introductory lecture was scheduled for November 16, 1762. Of this lecture Caspar Wistar records:[1]

> "The introductory lecture was delivered in one of the large apartments of the State-House, and many of the gentlemen of Philadelphia heard it with pleasure. . . . Such was the origin of our medical school!"

In the original notice Shippen advised the public that the managers and physicians of the Pennsylvania Hospital had encouraged his proposal and that they had granted him

> ". . . . the use of some curious Anatomical Casts and Drawings (just arrived on the *Carolina*, Capt. Friend), presented by the judicious and benevolent Doctor (John) Fothergill of London. . . ."

In March of 1763,[2] Shippen in addition to his anatomical lectures announced a course of lectures on midwifery in the following proposal:[3]

> "Doctor Shippen, Junior
>
> "Proposes to begin his first course on Midwifery as soon as a number of pupils sufficient to defray the necessary expense shall apply. A course will consist of about twenty lectures in which he will treat of that part of anatomy which is necessary to understand that branch, explain all cases in midwifery—natural, difficult, and preternatural—and give directions how to treat them with safety to the mother and child; describe the diseases incident to women and children in the month, and direct to proper remedies; will take occasion during the course to explain and apply those curious anatomical plates and casts of the gravid uterus at the Hospital, and conclude the whole with necessary cautions against the dangerous and cruel use of instruments.
>
> "In order to make the course more perfect, a convenient lodging is provided for the accommodation of a few poor women, who otherwise might suffer for want of the common necessaries on these occasions, to be under the care of a sober, honest matron, well acquainted with lying in women, employed by the Doctor for that purpose. Each pupil to attend two courses at least, for which he is to pay five guineas. Perpetual pupils to pay ten guineas.
>
> "The female pupils to be taught privately, and assisted at any of their private labors when necessary. The Doctor may be spoke with at his house, in Front Street, every morning between the hours of six and nine; or at his office in Letitia Court every evening."

[1] See footnote 3, page 147.

[2] Norris (loc. cit.) while quoting the date March, 1762, notes that Shippen's lectures on midwifery were delivered subsequent to his lectures on anatomy (November, 1762). It would seem probable, therefore, that the midwifery lectures, although announced early in 1763, were delivered at a much later date. Interest in anatomy on the part of physicians was naturally greater than in midwifery. Some misconception may have arisen due to the fact that in the course in anatomy, the gravid uterus was described and some remarks made on clinical midwifery. Probably no more than one lecture of the series on anatomy was devoted to what may be termed midwifery.

[3] Norris, loc. cit.

by a male physician. In his *Eulogium on Dr. Shippen*, Caspar Wistar gives a very clear picture of the prejudice with which male practitioners of midwifery were confronted:

> "It was only when something very important was to be done, that they (male practitioners) were resorted to—and, very often, when too late. This was altogether the effect of prejudice, and not of necessity, for several of the medical gentlemen were accoucheurs—and our late worthy president, Doctor Redman, had been declared, by Doctor Bond, to be the best obstetrical practitioner he had ever known—yet, he attended very few natural labours. By Shippen this prejudice was so done away, that in the course of ten years he became very fully employed. He also taught midwifery. Prior to the revolution, he seems to have had a distinct class of students in this branch: . . ."

On September 17, 1765, William Shippen, Jr. was chosen professor of anatomy and surgery in the College of Philadelphia. He continued his lectures on anatomy, which were uninterrupted until the winter of 1775–1776, when they were suspended because of the Revolution. In 1777 he succeeded John Morgan[1] (1735–1789) as Director-General of the Medical Department of the Army. Charges were preferred against him for his conduct while in office, but he was acquitted by court-martial in 1780 and reappointed Director two months later. He resigned in 1781.

Shippen is described as a brilliant lecturer, a man of polished manners and remarkable judgment in selecting what was pertinent in elucidating a principle. John W. Francis in the preface to his edition of Denman's *An Introduction to the Practice of Midwifery* says:[2]

> "The late Dr. William Shippen of Philadelphia, has the honour of having been the first public teacher of midwifery in the United States. While in Europe, he enjoyed the high advantage of the direct instruction of Dr. William Hunter, and on his return to his native country, was chosen professor of anatomy in the medical school of Pennsylvania. His lectures on obstetrics, like his course of instruction on anatomy and surgery, evinced profound knowledge of his subject, consummate ability, and unrivalled command over his auditory. Dr. Shippen's first course of midwifery was delivered in 1762."[3]

The efforts of Shippen bore fruit in that the private midwifery course which he inaugurated was continued long after the establishment of the chair of midwifery in the medical department of the University of Pennsylvania. For many years following the appointment of a professor of midwifery, the course was not required for graduation,[4] and many students preferred to take the extramural course without attendance upon the lectures of the regularly constituted professor in the university. Extramural instruction in anatomy was continued for many years and followed in conception the

[1] John Morgan was appointed Director-General of the Medical Corps in October, 1775, succeeding Benjamin Church (1734–1776) who had been dishonorably discharged for treason. Morgan set himself to bring order out of chaos, but largely due to the jealousy and insubordination of his regimental officers he was dismissed from the post in October, 1776. Morgan was one of the most distinguished of the early American physicians and the principal founder of what was to become the medical department of the University of Pennsylvania. His essay on medical education is a classic.

[2] New York, 1821.

[3] As noted previously, this date is probably erroneous.

[4] Thomas G. Morton and Frank Woodbury (loc. cit.) note that: "It was not, however, until 1843 that the Trustees of the University fully recognized the standing of this department of teaching by making attendance upon the lectures on midwifery obligatory upon the students, who expected to obtain the medical degree."

John Bard had received as good an apprentice training as the early colonies afforded. At an early age he was apprenticed to John Kearsley[1] (1685–1772) of Philadelphia with whom he spent seven years. He began practice in Philadelphia and soon married a niece of Mrs. Kearsley. After a few years of practice in Philadelphia, he was persuaded by Benjamin Franklin to remove to New York City because of the recent depletion of the ranks of the medical profession there by yellow fever. He became acquainted with Peter Middleton[2] (d. 1781) who was the acknowledged leader of the profession in New York and assisted Middleton in one of the earliest anatomical dissections (about 1750) in which the blood vessels were injected and the dissected cadaver preserved for the instruction of medical apprentices. Bard was one of the most distinguished of the early physicians.

Another interesting case of extra-uterine pregnancy occurred in the practice of **William Baynham** (1749–1814), a son of Dr. John Baynham of Caroline County, Virginia. Baynham went to London in 1769 where he spent sixteen years in the study and practice of anatomy and surgery, ultimately serving as assistant to Mr. Joseph Else[3] (d. 1780), surgeon to St. Thomas's Hospital. On the death of Mr. Else (1780), Baynham was an unsuccessful applicant for the vacancy thus created, the post going to Henry Cline[4] (1750–1827). In spite of his London success, which was notable, Baynham returned to Virginia in 1785 and settled in Essex County, where he practiced until his death. He was without doubt the best trained surgeon and obstetrician in any of the states of the newborn American union and was ranked as a worthy contemporary of Philip Syng Physick[5] (1768–1837). Unfortunately, Baynham was not connected with a teaching faculty in a center of medical education. Had he been so associated it is probable that he would have acquired by virtue of his training and ability preeminent rank in American surgery.

Baynham's report on extra-uterine pregnancy appeared in 1809 in the *New York Medical and Philosophical Journal and Review* (vol. i) and was one of the earliest accounts of this condition. His first case was that of a woman who consulted him in 1786 with the history that several years before she had been pregnant and at full term; that labor supervened but without effect and after a few hours she became conscious that the child was dead. No interference was attempted. For approximately a year subsequent to this

[1] John Kearsley came to Philadelphia from England about 1711. He took a prominent part in public affairs, established a large medical practice and as a result of his design for Christ Church in Philadelphia acquired some reputation as an architect.

[2] Peter Middleton studied at St. Andrews University. After coming to New York he assisted in the organization of the medical faculty of King's College and served as professor of pathology and physiology from 1767 to [illegible]; of chemistry and materia medica from 1770–1776; and was a governor of the college, 1770–1780.

[3] Joseph Else was elected a fellow of the Royal Society in 1778; was surgeon to St. Thomas's Hospital, and a member of the Royal Academy of Surgery of Paris. Many of his essays were collected after his death and published by George Vaux in 1728. In this collection his essay on the cure of hydrocele is of special interest.

[4] Henry Cline began practice in London in 1774; lectured on anatomy at St. Thomas's Hospital, 1781–1811, and was surgeon from 1784–1811.

[5] Philip Syng Physick, "Father of American Surgery," served one year as house-surgeon at Guy's Hospital, and before leaving London was elected to the Royal College of Surgeons. He was professor of surgery at the University of Pennsylvania, 1805–1819; professor of anatomy, 1819–1831; and emeritus professor of anatomy and surgery, 1831–1837. He was one of the first in America to use the stomach tube and his inventions in orthopedic surgery brought him wide fame.

(1843–1876),[1] obstetrician to the Philadelphia Hospital, in his monograph on extra-uterine pregnancy[2] gives a very comprehensive account of the condition with a table of cases.

Gradually, with improvements in means of communication and with the increase in the number of journals[3] devoted to clinical medicine, transactions of societies, etc., reports of operations for extra-uterine pregnancy performed at much earlier dates found their way into the literature and the early years of the nineteenth century in America witnessed a revival of interest and enthusiasm for improved midwifery.

Cesarean section, which is mentioned in early medical writings, was apparently not practiced upon the living subject until the fifteenth century. Many of the sixteenth and seventeenth century writers, although describing the operation and frequently detailing successful cases, do not claim to have performed the operation themselves, but abstract their accounts from the writings or sayings of usually distant surgeons. At best but isolated and sometimes apocryphal accounts are to be found until early in the eighteenth century when serious consideration was given to devising an operative procedure that offered a reasonable chance for the life of both mother and child. Some of the texts on surgery and midwifery of this period contain explicit directions for performing cesarean section. John Burton[4] gives considerable attention to cesarean section in his *Essay on Midwifery* (London, 1751), and advises the operation in case delivery appears to be otherwise impossible. Burton apparently never performed the operation himself as he says:

> ". . . those who have performed this operation tell us the hemorrhage is not very considerable."

He devotes seven pages to citations from the literature, following which he gives detailed directions for the preparation of the patient, instruments, bandages, and sponges. No mention is made in Burton's account of suturing the uterus.

The hazard of the operation, however, remained so great that few surgeons were bold enough to attempt the operation even in desperate cases. In the mid-period of the nineteenth century the mortality in several series of collected cases was found to be from 50 to 85 per cent. In 1878 Robert

[1] John S. Parry received his M. D. from the University of Pennsylvania in 1865, and served a residency in the Philadelphia Hospital. He was appointed visiting obstetrician to the hospital and assisted in reorganizing the lying-in wards and making the clinical material available for the use of the students. He had completed his book on extra-uterine pregnancy before his death, and his biographer, J. V. Ingham, lists thirty-five articles, reviews, etc. which he had written in his short period of active practice.

[2] *Extra-Uterine Pregnancy;* etc., Philadelphia, 1876.

[3] *The Medical Repository* founded in New York in 1797; *Philadelphia Medical Museum*, 1804; *Philadelphia Medical and Physical Journal*, 1804; *The Medical and Agricultural Review*, Boston, 1806; *Baltimore Medical and Physical Recorder*, 1808; *American Medical and Philosophical Review*, New York, 1810; *New England Journal of Medicine and Surgery*, Boston, 1812; *American Medical Recorder*, New York, 1818; *Philadelphia Journal of Medical and Physical Science*, 1820; *Western Quarterly Reporter of Medical, Surgical and Natural Science*, Cincinnati, 1822; *The North American Medical and Surgical Journal*, New York, 1826; *Ohio Medical Repository*, Cincinnati, 1826; *Western Medical and Physical Journal*, Cincinnati, 1827; *Transylvania Journal of Medicine*, Lexington, Kentucky, 1828.

[4] John Burton is mentioned elsewhere in connection with the development of the forceps.

used his best endeavors to divest himself of the obstetrical mantle and as a result in 1810 the trustees divorced anatomy from midwifery. This action was followed by a resolution that eliminated midwifery from the curriculum required for graduation.

The first encumbent of the then isolated chair of midwifery was **Thomas Chalkley James** (1766–1835), who was born of Quaker parentage in Philadelphia where his father was one of the leading merchants. He studied medicine under Adam Kuhn[1] (1741–1817) and in 1787 received the degree of bachelor of medicine from the University of Pennsylvania and in 1811 that of doctor of medicine. In 1790 he was a resident pupil with Drs. Osborn and John Clarke, two of the important teachers of midwifery in London. A second year was spent in Edinburgh where he formed a close friendship with another American student, David Hosack. He returned to Philadelphia and arrived but a short time before the outbreak of the fearful epidemic of yellow fever of 1793. In 1825 William P. Dewees, who, as we have noted, had announced himself a teacher of midwifery a few years prior to 1800, became his assistant and, although James held the chair for some years, the burden of teaching fell upon Dewees.

In 1813 James edited John Burns' (1775–1850) *The Principles of Midwifery* and in 1816 Samuel Merriman's (1731–1818) *A Synopsis of the Various Kinds of Difficult Parturition.* While the induction of labor in placenta praevia had been advocated by French obstetricians beginning with Guillemeau and had been followed spasmodically by many English obstetricians of note, the first positive statement in this regard from an American appears to be that of James who induced labor in a case of contracted pelvis, with a fortunate result for both mother and child. The induction of labor for contracted pelves, placenta praevia, etc., was later advocated by T. Gaillard Thomas (1831–1903) and had many followers.

James' successor at the University of Pennsylvania, **William P. Dewees** (1768–1841) (Fig. 65), was the first American to exert a wide influence upon midwifery. Through a long teaching career, although subordinate to James in academic rank, he became the outstanding teacher, writer and practitioner in this field. Upon James' resignation in 1834, Dewees, who had served since 1825 as adjunct professor, was appointed to the chair of midwifery. This promotion, however, came to Dewees in a period of marked ill-health which necessitated his resignation the following year.

His writings show a clear conception of certain gynecological conditions and, because of the grouping of special fields, he is to be remembered for his contributions to pediatrics. In 1807 he published an abridgment of Heath's translation of Baudelocque's *Midwifery.* Dewees' *Treatise on the Diseases of Females* (1826) went through ten editions and more than twelve editions of his *System of Midwifery* (1824) were issued. Friendly reviewers attributed

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the Pennsylvania Hospital, 1793–1810. On the appointment of Shippen to the professorship of anatomy, surgery and midwifery in the University of Pennsylvania, Wistar was designated his adjunct.

[1] Adam Kuhn received his M. D. from Edinburgh in 1767, and was appointed professor of botany at the University of Pennsylvania in the following year. He was physician to the Pennsylvania Hospital, one of the founders of the College of Physicians of Philadelphia. In 1789 he was appointed professor of the theory and practice of medicine in the University of the State of Pennsylvania and after the consolidation with the College of Philadelphia was professor of the practice of physic from 1792–1797.

Fig. 66.—Hugh Lenox Hodge. (From author's collection.)

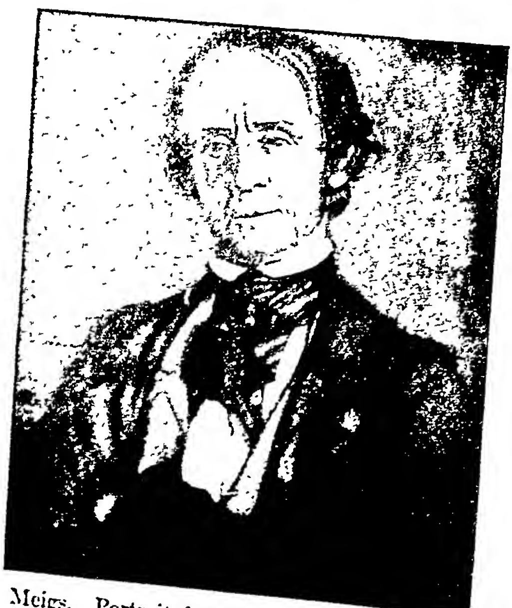

Fig. 67.—Charles D. Meigs. Portrait from article by Abraham Levinson in *Ann. Med. History*, 1928, vol. x, p. 138.

lated (Philadelphia, 1831) Alfred-Armand-Louis-Marie Velpeau's[1] (1795–1867) *Elementary Treatise on Midwifery.* Meigs also called particular attention to sudden death post partum, attributing this untoward circumstance to the formation of a thrombus in the right auricle.

Wherever the powerful influence of Jefferson Medical School and the Medical Faculty of the University of Pennsylvania was felt the teachings of Meigs and Hodge dominated. Neither can be said to have added much to the science of midwifery, although Hodge's contributions to a clearer understanding of the parturient canal constituted a real advance.

Formal instruction in midwifery in New York began in 1767 with the organization of a faculty of medicine under the auspices of King's College, and **John Van Brugh Tennent** (1737–1770) was appointed professor of obstetrics. His associates in the newly organized faculty were Samuel Clossy,[2] professor of anatomy; John Jones[3] (1729–1791), surgery; Peter Middleton, physiology and anatomy; James Smith,[4] chemistry and materia medica; and Samuel Bard, the practice of physic. Tennent was born in Bucks County, Pennsylvania, and after graduating from the College of New Jersey (Princeton), pursued his medical studies in Edinburgh where he was graduated in 1764. Tennent no doubt pursued the study of midwifery in London because at that time only slight attention was given to the teaching of clinical midwifery in Edinburgh. At any rate he must have spent considerable time in study in London for before he left England he was made a member of the Royal Society. Shortly after the organization of the medical faculty of King's College, Tennent developed signs of pulmonary tuberculosis and went to the West Indies, where his death occurred in 1770 following an attack of yellow fever.

The second professor of midwifery in King's College, **Samuel Bard** (1742–1821) (Fig. 68), was appointed in 1770. He was born in Philadelphia April 1, 1742, the son of Dr. John Bard. His mother was a niece of Dr. John Kearsley of Philadelphia, who had functioned as the medical preceptor of his father. Bard's preliminary education was secured in a private grammar school and at the age of fourteen he entered King's College, at the same time giving some attention to medical studies under the direction of his father. In the autumn of 1760 he sailed for Europe and reached London in the early summer of 1761, subsequent to a six months' imprisonment at the hands of the French, the vessel on which he left America having been captured by a French privateer.

[1] Alfred-Armand-Louis-Marie Velpeau succeeded Alexis Boyer (1757–1833) as professor of surgery at the Charité, but he devoted himself to midwifery as well as surgery.

[2] Samuel Clossy was born in Ireland and graduated from Dublin University. Before coming to America he had published in 1853 *Observations on some of the Diseases of the parts of the human body.* He returned to Ireland at the outbreak of the Revolution.

[3] John Jones was born in Jamaica, Long Island. After serving his medical apprenticeship under Thomas Cadwalader he went to London where he studied under William Hunter, Colin Mackenzie and Percivall Pott (1714–1788). He later journeyed to France where he paid particular attention to anatomy and surgery. He received his M. D. from Rheims. After spending some time at Leyden and Edinburgh he returned to New York to begin practice as a surgeon. Thacher says he performed the first lithotomy in New York City. His *Plain, Concise and Practical Remarks on the Treatment of Wounds and Fractures* was used by surgeons in the Revolution and he was active in the organization of the medical department of the army. He moved to Philadelphia in 1780 where he was appointed surgeon to the Pennsylvania Hospital. He was one of the founders of the College of Physicians of Philadelphia.

[4] James Smith received his M. D. from Leyden.

equipped hospital, and as a result of his appeal eight hundred pounds was promptly subscribed toward the project.

At the outbreak of the Revolution, Samuel Bard, who was a firm loyalist, established a temporary residence at Shrewsbury, New Jersey, but on the occupation of that city by the British, he returned to New York and re-established his practice. He is said to have served as personal physician to General Washington when the commander of the Continental forces established his headquarters in the vicinity of New York City. He was professor of chemistry in Columbia College (formerly King's College) from 1784 to 1787 and in 1792 when Columbia College established the faculty of medicine,[1] Dr. Bard was appointed dean of the faculty, which post he resigned in 1804. On the union of the faculties of medicine of Columbia College and the College of Physicians and Surgeons,[2] Bard was made president. In spite of his large practice, he devoted considerable time to civic affairs and was chiefly instrumental in the establishment of the New York City Public Library and the New York Dispensary. In 1795 he accepted David Hosack as a partner and three years later retired to a country estate.

Chief among Bard's writings must be ranked *A Compendium of the Theory and Practice of Midwifery*,[3] (Fig. 69) the first work on the subject from the pen of an American physician, which was published in 1807. Bard's chief interest in practice was midwifery. Certainly no New York physician took higher rank in this field than he, and his book went through three editions in its original form (duodecimo), and was twice published, considerably enlarged, in octavo. At the time of his death he was preparing the third enlarged edition.[4] In common with most midwifery authors of the day, Bard states in his introduction that he has noted how greatly midwives are in need of proper instruction; that because of their pecuniary situation as well as deficiencies of education they are unable to derive it from books; therefore, he has decided to set forth "a set of plain but correct directions" in a cheap book. He says:

> "This I have attempted in the following essay, in which it has been my object to be useful, rather than to appear learned; . . . and to detail such facts and observations, as have been long known, and have received the stamp of time and experience, rather than to offer new opinions."

Bard stamps himself a conservative obstetrician of the modern school when he decries the use of instruments, of operative interference, and the intro-

[1] The professors of midwifery in King's College and its successor, Columbia College, were as follows: John V. B. Tennent, appointed 1767, deceased 1770; Samuel Bard, appointed 1770, retired 1776; Ebenezer Crosby, appointed 1785, deceased 1788; John R. B. Rogers, appointed 1792, resigned 1808; Walter C. Buchanan, appointed 1808, resigned 1813.

[2] The professors of midwifery in the College of Physicians and Surgeons were: David Hosack, appointed 1807, retired 1808; William James Macneven, appointed 1808, resigned 1814; John C. Osborn, appointed 1814, resigned 1819; John W. Francis, appointed 1819, resigned 1826; Edward Delafield, appointed 1826, deceased 1841.

[3] It is a curious coincidence that one of the publishers of Bard's *Compendium* was Benjamin Douglas Perkins, the son of Elisha Perkins, the inventor of Perkins' tractors. Benjamin Perkins was the European agent for the tractors and had established in London a Perkinean Institute where the power of the tractors to cure disease was demonstrated. It was reported that Perkins amassed a fortune in Europe through the sale of the tractors.

[4] Actually the sixth edition.

cautions against following the dictates of Smellie in this respect no doubt came from his desire to minimize, insofar as possible, the use of the midwifery forceps. He notes that at the latter end of nearly thirty years of practice he has found much less use for instruments than at the beginning.

". . . we may certainly conclude that the person who, in proportion to the extent of his practice, meets with most occasions for the use of instruments, knows least of the powers of nature; and that he who boasts of his skill in their application, is a very dangerous man."

Referring to the delivery of the placenta, Bard antedates Carl Siegmund Franz Credé's[1] (1819–1892) method in the following instructions:[2]

". . . let an assistant or the woman herself, place her hand on the abdomen, a little above the fundus uteri, so as in some measure to grasp it in the palm, and make a moderate pressure upon it. This can possibly do no harm; it has been my general practice; and I think I have found a manifest advantage from it in promoting the contractions of the uterus, and disengaging the placenta."

The principle of drainage, advocated by Charles White, is followed:

"After one or two days, women should rise from their beds, and sit up for a longer or shorter time every day, according to their strength and inclination. . . . The natural discharges which flow from the womb after delivery, require no other attention than sitting up a short time every day to promote their evacuation . . ."

As may be understood, the influence of Samuel Bard on American midwifery was considerable. His teaching was conservative with perhaps too great reliance upon nature, setting an example, however, that was followed by John W. Francis.

Bard's successor in private practice, David Hosack (1769–1835), was graduated from Princeton in 1789 and from the medical department of the University of Pennsylvania in 1791. After a short period of general practice he spent two years in London and Edinburgh and returned to New York to enter into partnership with Samuel Bard. In 1795 he was made professor of botany in the medical faculty of Columbia College and in 1796 the subject of materia medica was added to his chair. In 1807 he was chosen professor of materia medica and botany, and lecturer on surgery and midwifery in the newly created College of Physicians and Surgeons, and in 1814 on the union of the College of Physicians and Surgeons with the medical faculty of Columbia he was appointed professor of the theory and practice of physic. In 1808 Hosack was relieved of his lectureship in midwifery and was succeeded by William James Macneven[3] (1763–1841), who was appointed professor of obstetrics and the diseases of women and children. This chair Macneven held until the combination of the two faculties, at which time he was appointed professor of chemistry. In 1814 John C. Osborn (1766–1819) was appointed professor of obstetrics and the diseases of women and children.

[1] Carl Siegmund Franz Credé, professor of obstetrics at Leipzig, is remembered for his method of manual delivery of the placenta and for his use of silver nitrate to prevent conjunctivitis in newborn children (1884). He was editor of the *Monatsschrift für Geburtskunde* (1854–1869) and of the *Archiv für Gynäkologie* (1870–1892).

[2] Fourth edition, New York, 1817, p. 187.

[3] William J. Macneven received his M. D. from the University of Vienna and practiced for a time in Dublin. A year prior to his appointment to the professorship in the College of Physicians and Surgeons he had delivered a series of lectures on midwifery in the New York Hospital, where he was a member of the staff.

Medical College and subsequently in the Albany Medical College. He later located in New York, where he was instrumental in the establishment of the medical faculty of New York University in 1841. Associated with him in this movement were Valentine Mott, professor of surgery; Granville Sharp Pattison[1] (1791–1851), professor of anatomy; John Revere[2] (1787–1847), professor of the theory and practice of medicine; Martyn Paine[3] (1790–1877), professor of the institutes of medicine; and John W. Draper[4] (1811–1882), professor of chemistry and diseases of women and children. Dr. Bedford held the chair of obstetrics until 1864 when ill-health compelled his resignation. He was the first to establish a clinic for diseases of women which was inaugurated shortly after his appointment as professor of midwifery. His *Diseases of Women and Children*, published in 1855, and his *Principles and Practice of Obstetrics*[5] (1861) exerted a wide influence throughout the United States and were translated into both German and French. His text on midwifery was the most scholarly that had been issued by any American author. Not only did the volume embody the author's teaching, but it included a review of the earlier literature of obstetrics. The American reviewers were lavish in their praise of Bedford's midwifery and the *Edinburgh Medical Journal* said:

> "The Book is, as a whole, so good that we wish our readers to be impressed with a sense of its soundness, readableness, and worth. . . . We can, therefore, give Dr. Bedford's volume no higher praise than to say it is remarkable among its contemporaries for soundness in scientific view, readableness as a literary composition, and worth as a guide of practice."

Bedford's discussion of puerperal fever is the most comprehensive that had appeared up to that time and he gives a correct account, taken from Braithwaite's *Retrospect*[6] of the experience of Semmelweis. He also quotes Robert Collins and strongly endorses his plan of isolation of the sick patient. He refers to the non-contagious idea of Meigs and Hodge as follows:

> "I do not deem it necessary to cite particular examples in which puerperal fever has been conveyed through the principle of contagion—they are so numerous, and so free from all doubt—in a word, they are so conclusive that I cannot conceive how they can be regarded otherwise than completely demonstrative of the point at issue."

There is much in Bedford's book that has been preserved in modern mid-

[1] Granville Sharp Pattison, a pupil of John and Allan (1781–1813) Burns of Glasgow, came to Baltimore from Glasgow in 1818 and was appointed professor of anatomy in the University of Maryland; professor of anatomy at Jefferson Medical School from 1831 to 1840.

[2] John Revere, a son of the famous colonial patriot and silversmith Paul Revere, received his M. D. from Edinburgh in 1811; was elected professor of the theory and practice of medicine at Jefferson Medical School in 1831.

[3] Martyn Paine graduated from Harvard College in 1813 and received his M. D. from Harvard Medical School in 1816. After practicing for a time in Montreal he moved to New York in 1822. Through his efforts the law forbidding dissection of human bodies was repealed.

[4] John W. Draper was born near Liverpool and came to America in 1833. He received his M. D. from the University of Pennsylvania in 1836. Later he was professor of chemistry at William and Mary College and at Hampden Sidney College, Virginia. He was the pioneer in photography in the United States.

[5] The book was in such demand that a second edition was called for within four months of publication.

[6] Part 23d, p. 492. See also part 24, p. 378, London, 1851.

1847, with a second edition somewhat enlarged in July of that year.[1] The *Treatise* consists of four hundred pages and is an amplification of his earlier pamphlet. Channing defines his objective thus:

> "My object was to learn if this use of it had been safe—safe both to *mother* and to *child;* and thus, as far as such results might reach, to contribute something towards settling the most important point concerning its further use, namely, that of its safety."

In his discussion he endeavors to consider all the circumstances relative to pregnancy and labor that might in any degree interdict the use of ether and concludes that there are no conditions associated with pregnancy that preclude the cautious employment of ether. He quotes James Y. Simpson's letter to Professor Meigs of Philadelphia, and indicates that chloroform, suggested by Simpson, is much more dangerous in that the transition from light to deep anesthesia, with the use of chloroform, is exceedingly rapid. Channing believes that the paralysis of the medulla so feared by Professor Meigs will not occur if the pulse and respiration are carefully watched and the amount of ether regulated accordingly. Time and again he notes that both pulse and respiration have been normal with the patient insensible to pain. Channing states that he has proved that ether may render the patient insensible to pain and at the same time the contractions of the uterus will proceed normally. He notes that etherization should simulate sleep; that unconsciousness may be more apparent than real as he has had numerous cases in which everything said is remembered, but the patient felt no pain. Channing answers the points alleged against the use of ether in midwifery, namely, that ether produces puerperal mania, convulsions, and predisposes to profuse hemorrhage, by his case reports proving that the much feared complications have not occurred in his series. Relative to the religious objection urged against the use of ether, Channing states that this objection is an exceedingly futile one and as far as it is based on Genesis III, 16,[2] has evidently arisen from a misconception of the text. He says the moral objection is equally as weak as the religious, as we should be forced to strike from our list of materia medica opium and a number of other important remedies. From contemporary reports we learn that Channing's book greatly stimulated the use of ether in midwifery. The *Proceedings of the Edinburgh Obstetrical Society* for 1848 include a report by James Y. Simpson on the employment of chloroform in midwifery. Accompanying the article are numerous communications in support of Simpson's position from Dr. Grigor of Nairn, Professor Dyce of Aberdeen, Mr. Lawrence of Montrose, Dr. Paton of Dundee, Dr. Anderson of Glasgow, etc. Simpson's use of chloroform in midwifery began in November, 1847.

Clinical midwifery in the middle west was greatly advanced by **Henry Miller** (1800–1874) who was born at Glasgow, Kentucky. He began the study of medicine under two local practitioners, and completed his education in Transylvania University, Lexington, Kentucky, graduating in 1822. The

[1] Channing says that the first use of a general anesthetic in midwifery was that of N. C. Keep of Boston who used ether on April 7, 1847. Dr. Keep reported his case in the *Boston Medical and Surgical Journal* for April 14, 1847. Channing reported a second case of deep ether anesthesia for operative delivery as occurring on May 5, 1847.

[2] Genesis III, 16. "Unto the woman he said, I will greatly multiply thy sorrow and thy conception; in sorrow thou shalt bring forth children; . . ."

tice of Medicine and Surgery applied to the Diseases and Accidents incident to Women (Philadelphia, 1888).

As we have noted, departments of midwifery by the middle of the nineteenth century had for the most part become established in American medical schools. Midwifery was, however, combined with pediatrics and gynecology and we will note that this situation obtained in some schools well-nigh until the end of the century. Beginning in the early twenties, there frequently appeared such academic titles as "professor of obstetrics and of diseases of women and children," or "professor of diseases of women and children and midwifery." For example, T. Gaillard Thomas was "professor of obstetrics and diseases of women and children" in the College of Physicians and Surgeons in New York; Charles D. Meigs was "professor of midwifery and the diseases of women and children" at Jefferson Medical School; William T. Lusk[1] (1838–1897) was "professor of obstetrics and diseases of women and children" at Bellevue. As gynecology became more surgical in character, with less reliance upon medical management, it was frequently coupled with general surgery, particularly with surgery of the abdomen. Academic titles then changed somewhat, and titles such as "professor of abdominal surgery and gynecology" became more numerous. Obstetrics and diseases of children were linked together, however, until the late eighties, or early nineties, when pediatrics became a generally recognized special field.[2] As the result of superior surgical training on the part of obstetricians and a clearer recognition of the physiology and pathology of the female pelvis, gynecology and midwifery have in most quarters become reunited. The separation of gynecology from surgery occurred when it was recognized that the general surgeon could scarcely be a master in a field of surgery so highly technical and requiring prolonged and intensive study for its practice and improvement. Other titles selected coincident with the establishment of some of our early medical schools follow in general the same plan. For example: At the Transylvania Medical School[3] William H. Richardson was professor of obstetrics and diseases of women and children; at the Vermont Academy of Medicine[4] Theodore Woodward (1788–1840) was professor of the principles and practice of surgery, obstetrics and diseases of women and children; at the Medical College of Ohio,[5] John Moorehead was professor of materia medica and medical obstetrics; at the University of Vermont Medical School[6] Henry S. Waterhouse was professor of surgery and obstetrics in 1827; at the Berkshire Medical

[1] William T. Lusk studied medicine in Heidelberg and Berlin, and after the Civil War completed his studies at Bellevue Medical College; after his graduation he spent two years in Paris, Vienna and Edinburgh. He became professor of obstetrics and diseases of women and children in the Bellevue Hospital Medical College about 1870 and held the chair until his death. His *Science and Art of Midwifery* published in 1882 went through four editions and was translated into French, Italian, Spanish and Arabic.

[2] Abraham Jacobi (1830–1919), one of the most colorful characters in American medicine, began lecturing on diseases of children at the New York College of Physicians and Surgeons in 1857. He was one of the founders of the *American Journal of Obstetrics* and organized in New York City a clinic for diseases of children; this followed by twenty years the organization of the midwifery clinic by Gunning S. Bedford. Jacobi held the first professorship of pediatrics in an American institution (1860).

[3] Established at Lexington, Kentucky, in 1817.

[4] Established at Castleton, Vermont, in 1818.

[5] Established at Cincinnati, Ohio, in 1819.

[6] Established at Burlington, Vermont, in 1822.

generally found this powder to be useful, are when the pains are lingering, have wholly subsided, or are in any way incompetent to exclude the fetus. Previous to its exhibition it is of the utmost consequence to ascertain the presentation, and whether any preternatural obstruction prevents the delivery; as the violent and almost incessant action which it induces in the uterus precludes the possibility of *turning*. The pains induced by it are peculiarly *forcing;* though not accompanied with that distress and agony, of which the patients frequently complain when the action is much less. My method of administering it is either in decoction or powder. Boil half a drachm of the powder in half a pint of water, and give one third every twenty minutes till the pains commence. In powder I give from five to ten grains; some patients require larger doses, though I have generally found these sufficient."

The letter continues:

"It is a vegetable, and appears to be a spurious growth of rye. On examining a granary where rye is stored, you will be able to procure a sufficient quantity from among that grain. Rye which grows in low, wet ground, yields it in greatest abundance. I have no objections to your giving this any publicity you may think proper."

John Stearns was born at Wilbraham, Massachusetts. He graduated from Yale College in 1789 and studied medicine with a preceptor, Erastus Sergeant (1742–1814) of Stockbridge, Massachusetts, later spending some time at the University of Pennsylvania. He began practice in 1793 in Saratoga County, New York, but in 1810 removed to Albany and in 1819 to New York City. He was one of the organizers of the Medical Society of the State of New York, its first secretary in 1807, and president in 1817. He was the first president of the New York Academy of Medicine which was organized in 1846.

Probably the most valuable contribution to American midwifery before 1860 was that made by **Marmaduke Burr Wright** (Fig. 70) in the development of bimanual cephalic version. Wright was born in Pemberton, New Jersey, November 10, 1803. He began the study of medicine with a preceptor, later attending the University of Pennsylvania, where he graduated in 1823, locating shortly thereafter in practice in Columbus, Ohio. In 1838 he was appointed professor of materia medica at the Medical College of Ohio (Cincinnati), and in 1840 was transferred to the chair of obstetrics. Due to a quarrel in the Cincinnati faculty he was removed from his professorship in 1850. In 1860 he was reelected to the same chair, which he retained until his retirement in 1868. He was one of the founders of the Ohio State Medical Society (1846), and its president in 1861.

Wright described his procedure of cephalic version in a paper read before the Ohio State Medical Society at a session held in the city of Cincinnati June 6, 1854. The paper was published in the transactions of the society for that year. It appears that Wright had practiced cephalic version with unusual success and his paper was based upon considerable experience in cases of shoulder presentation, in the manipulation of which he had become unusually expert. The minutes of the Ohio Medical Society for the session in 1854[1] record that:

"The Committee appointed at the last meeting to 'Award the medal presented by the Montgomery County Medical Society to the Ohio State Medical Society, as a prize to be awarded to the author of the best essay on any Medical topic,' reported through its Chairman, Dr. R. Thompson, that the Committee had awarded the prize to the author of an

[1] Vol. ix.

center of the uterine cavity. The body is thus made to assume its original bent position, the points of contact loosened, and perhaps diminished, and the force of adhesion is in a good degree overcome. Without any direct action upon the head it gradually approaches the superior strait, falls into the opening, and will, in all probability, adjust itself as a favorable vertex presentation. If not, the head may be acted upon as in deviated positions of the vertex, or it may be grasped, brought into the strait, and placed in correspondence with one of the oblique diameters. . . .

"*Pushing up the shoulders*, therefore, does not constitute a prominent part of turning, if by pushing up is meant the mere raising of the shoulders above the brim of the pelvis.

"As the body of the fetus makes its curved movement under the hand of the operator, it advances upward, as well as laterally, by a combined rather than a single action, which would give it only one direction.

"The back of the hand, with which we have been acting upon the shoulder, is toward the head of the fetus—consequently, its hold upon the head would be apparently slight—yet, after the shoulders have reached the iliac fossa, the vertex may fall upon the palm of the hand in occupying the strait, and its adjustment become easy."

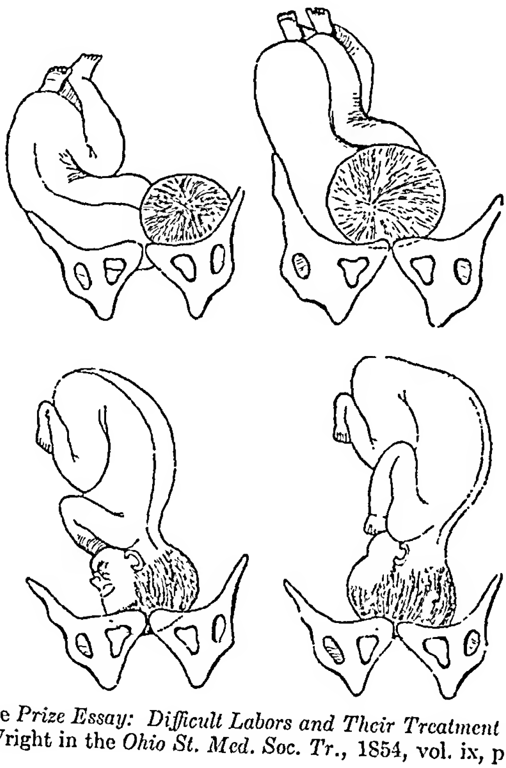

Fig. 71.—From the *Prize Essay: Difficult Labors and Their Treatment* by Marmaduke Burr Wright in the *Ohio St. Med. Soc. Tr.*, 1854, vol. ix, p. 88.

Included in Wright's essay are case reports excerpted from the *Western Lancet.*[1] The first is a report by Dr. B. F. Richardson in the February number entitled *Cephalic Version; Nine Hours after the Rupture of the Membranes* and the second is a report by J. P. Walker, published in the May number entitled *A Case of Labor, with Shoulder Presentation and Cephalic Version.* Both reports detail cases of difficult labor in which Dr. Wright had been called in consultation and in which he performed cephalic version to correct shoulder presentations. Dr. Richardson says that:

[1] Vol. xii, 1851.

in the *Transactions of the Ohio State Medical Society* for 1854 a careful reading and hence concluded that Wright's method did not involve the use of both hands. Hicks subsequently restated his position and gave Wright full credit for bimanual cephalic version although stating correctly that he (Hicks) carried the procedure much further by causing the head to engage through pressure on the breech and applying the method as well to podalic version. Hicks says:

"By its means one can make a complete podalic presentation out of a cephalic, with only one or two fingers in the os uteri, and this with a precision and security which leaves little more to be desired. I think I am not exceeding my rights, when I claim that till I first described the plan in 1860, no one else had done so."

In the *American Journal of Obstetrics* (vol. xii) for 1879, Dr. Hicks published a communication entitled *On Combined External and Internal Version of the Fetus in Utero* in which he says:

"I have already . . . made some remarks . . . , for the purpose of admitting, firstly that, so far as the case of cephalic version was concerned, Dr. Wright had the right of priority in the recommendation of the use of the external hand to press the breech of the fetus to the fundus uteri; or, in his own words, 'to dislodge the breech,' 'to loosen the contact and perhaps diminish the force of adhesion'; and secondly, with the view of claiming a place for myself as an independent discoverer of this method of cephalic version, and also the priority of a much greater advance, namely, complete as well as partial cephalic version, by the use of the hand outside and inside the womb."

It seems perfectly clear that Wright is entitled to priority in devising a method of bimanually converting a shoulder into a cephalic presentation, and America obstetricians have claimed for Wright's description all that Braxton Hicks chose to attribute to his method of bimanual version, published nearly ten years later. Subsequently **Richard A. F. Penrose** (1827–1908) of Philadelphia described cephalic version in shoulder presentations in 1855[1] with apparently no knowledge of Wright's earlier publication. Penrose was professor of midwifery and diseases of women and children in the University of Pennsylvania from 1863 to 1889 and is described as a brilliant teacher whose chief reliance was upon manikin demonstrations.

American physicians played a stellar rôle in the development of the science of gynecology and our very familiarity with the names of Ephraim McDowell, J. Marion Sims, Robert Battey, Nathan Bozeman (1825–1905) and many others attests the importance of their contributions. To catalogue the advances made by American physicians and surgeons in this field would prove a well-nigh impossible task. Mention, however, must be made of a few of the "landmarks" that have illumined the pathway to modern procedures.

In the year 1809, Danville, Kentucky,[2] was a "far-cry" from the centers of medical learning and yet in that year there was performed in Danville, for the first time, an epoch-making surgical operation unrivalled in boldness. **Ephraim McDowell** (1771–1830) (Fig. 72), the surgeon, was thirty-eight years of age and the leading surgeon and physician west of the Alleghenies. His medical training was that of the Edinburgh school, where his preceptor, Dr. Humphreys of Staunton, Virginia, had graduated and where in 1793–1794

[1] *Medical Examiner*, July, 1855.
[2] In 1809 Mercer County, now Boyle County.

McDowell's clear, concise language appeared in the *Eclectic Repertory and Analytical Review* of Philadelphia for 1817.[1]

Shortly after the appearance of McDowell's report his procedure was caustically criticized in paragraphs appearing in the same journal, and the elder Meigs (Charles D.) thundered at McDowell much as he thundered at Oliver Wendell Holmes some thirty years later. McDowell must have been somewhat exasperated for in the report[2] of his second group of cases, he answers his critics in a few ringing sentences filled with rebuke, giving at the same time a clear picture of one who, through ability and attainment, personified the science of surgery. He says:

"I thought my statement sufficiently explicit to warrant any surgeon's performing the operation, when necessary without hazarding the odium of making an experiment; and I think my description of the mode of operating and of the anatomy of the parts concerned clear enough, to enable any good anatomist, possessing the judgment requisite for a surgeon, to operate with safety. I hope no operator, of any other description may ever attempt it. It is my most ardent wish, that this operation may remain to the mechanical surgeon forever incomprehensible. Such have been the bane of the science; intruding themselves into the ranks of the profession, with no other qualification but boldness in undertaking, ignorance of their responsibility, and indifference to the lives of their patients; proceeding according to the special dictates of some author, as mechanical as themselves, they cut and tear with fearless indifference, utterly incapable of exercising any judgment of their own in cases of emergency; and sometimes, without possessing even the slightest knowledge of the anatomy of the parts concerned.

"The preposterous and impious attempts of such pretenders, can seldom fail to prove destructive to the patient, and disgraceful to the science. It is by such this noble science has been degraded in the minds of many, to the rank of an art."

The most openly expressed doubt appeared from the pen of James Johnson, the learned editor of the *Medico-Chirurgical Review of London*. Johnson's first knowledge of McDowell's operation came from the publication of John Lizars'[3] (1783–1860) paper[4] in which McDowell's original report was incorporated. Johnson says:[5]

"We candidly confess that we are rather skeptical concerning these statements and we are rather surprised that Mr. Lizars should put implicit credence in them. . . . The second case is little less extraordinary if not incredible. . . ."

It remained, however, for Johnson in a later article[6] to apologize handsomely as follows:

"A back settlement of America—Kentucky, has beaten the mother country, nay Europe itself, with all the boasted surgeons thereof, in the fearful and formidable operation of gastrotomy[7] with extraction of diseased ovaria. In the second volume of this series,

[1] McDowell had forwarded, a short time before, a copy of his report to Dr. John Bell who at the time was absent in Italy, and the report fell into the hands of John Lizars, a pupil of Bell's and his *locum tenens*.

[2] *Eclectic Repertory and Analytical Review.* Philadelphia, 1819, vol. ix.

[3] John Lizars, a pupil of John Bell, began to teach anatomy to private pupils in 1815. He was the first in Scotland to ligate the innominate, and followed McDowell's case reports in performing ovariotomy. He published his *Observations on the Extirpation of Diseased Ovaria* in 1825.

[4] *Edinburgh Medical and Surgical Journal*, 1824.

[5] *Medico-Chirurgical Review.* London, January, 1825.

[6] Ibid.

[7] An operation involving opening the abdomen was called "gastrotomy."

point in his career. He had become a popular practitioner and was well and favorably known as a safe and progressive surgeon. In the summer of that year his attention was called to several cases of vesicovaginal fistula in young negro women. In his autobiography,[1] he vividly describes the concern which these patients gave him. He read the literature faithfully without finding a satisfactory method of cure. Then came the discovery of the Sims' position and the invention of the duck-bill speculum. A Mrs. Merrill had fallen from a horse and had sustained a sudden retroversion of the uterus. Remembering the advice of his Charleston teacher, Dr. Thomas G. Prioleau, Sims placed the patient in the knee-chest position. In describing this incident, he says:

Fig. 73.—J. Marion Sims. (From the author's collection.)

"I turned my hand with the palm upwards and then downwards and pushing with all my might, when all at once I could not feel the womb nor the walls of the vagina. I could touch nothing at all, and wondered what it all meant. While I was wondering Mrs. Merrill said, 'Why, doctor, I am relieved.'

"Then, said I to myself, if I can place the patient in that position, and distend the vagina by the pressure of air, so as to produce such a wonderful result as this, why can I not take the incurable case of vesico-vaginal fistula, which seems now to be so incomprehensible, and put the girl in this position and see exactly what are the relations of the surrounding tissues? . . . I jumped into my buggy and drove hurriedly home. . . . I stopped and bought a pewter spoon. I went to my office where I had two medical students, and said, 'Come, boys, go to the hospital[2] with me.'

" 'You have got through your work early this morning,' they said.

" 'I have done none of it,' I replied; 'come to the hospital with me.' Arriving there, I said, 'Betsy, I told you that I would send you home this afternoon, but before you go

[1] *The Story of My Life.* By J. Marion Sims. New York, 1889.

[2] For the care of negro patients, Sims had a small eight-bed hospital erected in one corner of his yard.

material of silver wire which was made for him by Mr. Swan, a jeweler, and in May, 1849, he operated for the thirtieth time upon one of his patients, Anarcha. To his delight there was no cystitis. When the time came to remove the suture, he says:

"With a palpitating heart and an anxious mind, I turned the patient on her side, introduced the speculum (Fig. 74), and there lay the suture apparatus just exactly as I had placed it. There was no inflammation, there was no tumefaction, nothing unnatural, and a very perfect union of the little fistula."

In the course of the next two weeks fistulae in two other patients were permanently closed by the same method. After nearly four years of experiment, success had come.

Six weeks after the conclusion of his first successful fistula operation, Sims completely collapsed with a severe dysentery which became chronic and held him in its grip for six long years. In search of health, he journeyed to springs, to his old home, to New York, to various points in New England, and back again to Montgomery, Alabama. October, 1851, found him in Montgomery

". . . thin and emaciated and exceedingly irritable. At last I was compelled to go to my bed. I thought that I should die. While lying in bed I wrote out the history of my operations for vesico-vaginal fistula for the press, and sent the article to Dr. Isaac Hays, the editor of *The American Journal of the Medical Sciences*. It was published in the January number of that journal (1852) as my last freewill offering to the medical profession before I should quit this world."

Sims improved, however, and returned to New York early in 1852. His illness dragged along, although he noticed that his condition was somewhat relieved by residence in the east, and in May, 1853, he decided to make New York his home for the remaining months of his life.

He was unsuccessful in obtaining a hospital appointment in New York City and received a cold though courteous reception from Drs. Valentine Mott, Alexander H. Stevens, and others, who had read his article and for whom he successfully demonstrated his method of repair of vesicovaginal fistula.[1] To his great credit, it should be recalled that John W. Francis became and remained a real friend. Sims' proposal to found a hospital for women met with but indifferent response on the part of the medical leaders. In 1854, however, through the influence of a casual friend, a newspaper reporter, Henri L. Stuart, who had heard Sims' story and who had absorbed his enthusiasm, a call was issued for a public meeting to be addressed by Sims on the importance of organizing a woman's hospital. Practically all of the New York papers of May 17, 1854, carried the following announcement, which was inserted through the influence of Stuart, who managed the whole affair:

[1] Of one of the New York surgical leaders, Sims says: "Dr. B— was exceedingly anxious to see me perform some of my operations with the silver suture, and so invited me to go and help operate on a Mrs. C—, who had a lacerated perineum, and whom he had operated upon unsuccessfully two or three times. I gladly went with him, loaned him my instruments, and showed him how to perform the operation. . . . A week or two after this Dr. B— came to me to borrow my instruments to operate on a case of vesico-vaginal fistula in the New York Hospital. I loaned him the instruments, and would gladly have gone with him to assist him in the operation, but he did not invite me. I felt very much hurt by it. . . ." *The Story of My Life*, p. 268.

Emmet always regretted the interruption which came to Sims' career incident to the Civil War and his years of residence in Europe. While honor thereby accrued to American gynecology, yet, as Emmet says:

"Sims never advanced beyond the work which he described in the remarkable paper delivered before the New York Academy of Medicine previous to his departure."

Relative to his own contributions, Emmet says:

Fig. 75.—Thomas Addis Emmet. From *The Birthday Dinner to Thomas Addis Emmet, M. D., LL. D., given by his Professional Friends at Delmonico's, New York, May 29, 1905.* New York, 1905.

"Much good was accomplished by demonstrating the existence of lacerated cervix and the close relation of the injury to epithelioma, if it be not the actual cause. The operation for repair filled an important place, but a still greater advance was made on showing the greater necessity for amputation, when it was discovered by me that in many cases the character of the lesion had become changed owing to the use of aseptic midwifery. Yet, it is difficult to determine if the good which has been obtained under all favorable circumstances counterbalances the evil from the great abuse which has existed from operating unnecessarily, as well as from neglect on the other hand where an operative procedure should have been employed. The discovery of this injury and operation gave me a world-wide reputation, and yet I have never been satisfied. From some unexplainable cause the profession at large has never mastered the subject in detail sufficiently to enable the good derived to compensate for the amount of injury resulting from ignorance or want of dexterity."

From a perusal of a number of personal letters from Emmet,[1] it is clear that

[1] In library of Northwestern University Medical School.

Battey's second case report was that of a young woman, twenty-three years old, who had come under his professional care in July, 1865. During the period from the time he first saw her until he decided upon operative procedure, there had occurred no normal menstrual flow. The suggestion that artificial menopause be induced met with the hearty cooperation of the patient and on August 17, 1872, Dr. Battey, with the assistance of several colleagues, removed both ovaries through an abdominal incision, the wound being closed with silver wire sutures. As we can readily understand, peritoneal infection resulted, but, after an illness of more than a month, the patient was convalescent. Reviewing the case and the rather stormy post-operative course, Battey remarks:

> "It is my deliberate opinion, that I have often seen this young lady suffer as much in body and mind, and equally as much in peril of her life, from her amenorrhoeal paroxysms, as she has suffered from the surgical procedure to which I have subjected her. This opinion is fully corroborated by the experience of the patient and the observation of her friends, in as far as they are capable of judging."

Battey notes that in this case he had received many valuable professional courtesies from Professor Samuel D. Gross of Philadelphia, Professor Paul F. Eve of Nashville, Professor Horatio R. Storer of Boston, and Professor W. F. Westmoreland of Atlanta.

Dr. Battey presented at the first meeting of the American Gynecological Society a summary report of ten cases in which the ovaries. still in a state of functional activity, were removed in connection with causes set forth in the paper. At the second meeting he presented a paper[1] entitled *Is there a proper field for Battey's operation?* in which he reports two additional cases of his own and fifteen cases at the hands of others. Concluding his paper Battey says that he believes that his operation is indicated:

> "1st. In those cases of absence of the uterus in which life is endangered or the health destroyed by reason of the deficiency, the removal of the ovaries is at once the hopeful, and the only means of permanent relief.
>
> "2d. In cases where the uterine cavity or vaginal canal has become obliterated and cannot be restored by surgery, if grave symptoms be present, the removal of the ovaries becomes a last and only resort and may be hopefully invoked in the case.
>
> "3d. In cases of insanity, or confirmed epilepsy, dependent upon uterine and ovarian disease, the operation is justifiable as a last resort and when other means of cure have failed.
>
> "4th. In cases of long protracted physical and mental suffering, dependent upon monthly nervous and vascular perturbations, which have resisted persistently all other means of cure, the question of a resort to the operation is to be committed to the prudent judgment of the conscientious practitioner in each particular case."

Sad to relate, Battey's operation fell somewhat into disrepute, largely because gynecologists failed to apply the procedure in carefully studied cases: cases that fell under one of the four "indications." Battey's priority of publication is unquestioned.

Robert Battey was born in Augusta, Georgia. He attended Phillips Academy, Andover, Massachusetts, subsequently graduating from the Philadelphia College of Pharmacy. He then entered upon the study of medicine with his brother, George M. Battey, and following this period attended two

[1] *Transactions of the American Gynecological Society*, 1877, vol. ii, p. 279.

notably by Horatio R. Bigelow[1] and Franklin H. Martin[2] (b. 1857). In 1892 Martin published *Electricity, Diseases of Women and Obstetrics* in which, after giving a description of the forms of electricity and the apparatus employed, the author outlines the therapeutic applications of electricity to gynecology and obstetrics. In the methods of treatment described, he follows with some modifications the régime of Apostoli. Treatment of uterine fibroids with or without the presence of hemorrhage, endometritis, metritis, and various inflammatory and proliferative conditions, strictures of the cervix, cancer, sterility, dysmenorrhea and amenorrhea and finally the use of galvanocautery, are fully discussed and case reports cited. In this work, the author reports cases that appeared to him to be clinically cured, although mentioning cases wherein he believed electrical treatment had no effect.

In spite of the numerous clinical cures reported by Apostoli, leaders in English gynecology, with the notable exception of Spencer Wells[3] (1818–1897), held aloof and declined to share the enthusiasm for his methods evinced by their American colleagues. In 1888 Apostoli attended the meeting of the British Medical Association at Glasgow in an effort to allay criticism and substantiate his electrotherapeutic régime. Illustrative of the ever-present skepticism and doubt surrounding the use of electricity as a therapeutic agent should be mentioned the question seriously discussed at the International Electrical Congress held in Frankfurt in 1891: "Can therapeutic results be achieved by the electric current that cannot be achieved by suggestion?" Credit must be accorded Apostoli, however, for his emphasis upon the importance of measurement of the electrotherapeutic dose and for his work in calibrating the apparatus employed. He devised many ingenious pieces of equipment, some of which are used in principle in the present-day application of radium.

No narrative of American gynecology could fail to mention the brothers, **John Light Atlee**[4] (1799–1885) and **Washington Lemuel Atlee**[5] (1808–1878) (Fig. 76), both of whom contributed much to ovariotomy. Washington Atlee

[1] Horatio Ripley Bigelow, fellow of the British Gynecological Society, member of the Philadelphia Obstetrical Society and of the Société Française d'Électro-Therapie; author of numerous works on electrotherapy including *Gynaecological Electro-Therapeutics*, London, 1889. In 1894 he edited *An International System of Electrotherapeutics*.

[2] Franklin H. Martin, M. D., Northwestern University Medical School, 1880; professor of gynecology at the Chicago Polyclinic in 1886 and, with W. F. Coleman, founder of the Post-Graduate Medical School in 1888; director-general (founder) of the American College of Surgeons; founder and editor-in-chief of *Surgery, Gynecology and Obstetrics* and *International Abstract of Surgery*.

[3] Sir Thomas Spencer Wells was a pupil of William Stokes (1804–1878), Robert J. Graves (1798–1853) and Benjamin Travers (1783–1858). He served as surgeon in the Royal Navy from 1841 to 1848 and then returned to London. He performed his first successful ovariotomy in 1858. He was president of the Royal College of Surgeons; surgeon to Queen Victoria; received his baronetcy in 1883.

[4] John Light Atlee received his M. D. from the University of Pennsylvania in 1820. His first ovariotomy was performed June 29, 1843, with a successful result. During the next forty years he performed the operation seventy-eight times with sixty-four recoveries.

[5] Washington Lemuel Atlee received his M. D. from Jefferson Medical College in 1829. In 1845 he was appointed professor of medical chemistry at the University of Pennsylvania. In thirty-four years he performed 387 ovariotomies. Of his work in the removal of uterine fibroids, Marion Sims says (*New York Medical Journal*, April, 1874): "The name of Atlee stands without a rival in connection with uterine fibroids . . . no man has yet dared to imitate him." He was a founder and an active member of the American Gynecological Society.

each subject in teaching institutions. While most of the older and strongly entrenched schools delayed the adoption of the suggestion, yet by the early seventies, six teaching institutions had created chairs of diseases of women (medical and surgical). It was not until the advent of antiseptic surgery, however, that American and world gynecology forged ahead, and with rapid strides practically dominated the field of abdominal surgery. Much of the present-day development in surgery of the abdominal cavity may be directly traced to gynecologists. In the two decades prior to 1880, many important monographs and texts appeared: T. Gaillard Thomas'[1] (1831–1903) *Practical Treatise on the Diseases of Women* in 1868; Edmund Randolph Peaslee's[2] (1814–1878) *Ovarian Tumors, Their Pathology, Diagnosis, and Treatment, Especially by Ovariotomy* in 1872; Alexander Skene's[3] (1837–1900) *Diseases of the Bladder and Urethra of Women* in 1878; Thomas A. Emmet's *Principles and Practice of Gynecology* in 1879; William Goodell's[4] (1829–1894) *Lessons in Gynecology* in 1879, and an important and valuable revision of William H. Byford's gynecology in 1881.

In his *History of American Gynecology*, which appears elsewhere in these volumes, Dr. Howard A. Kelly has included the modern era. In that chapter the reader is acquainted with the story of gynecology presented from the viewpoint of one who has enjoyed a lifetime of intimate personal contact with the majority of America's leaders in that special field.

French gynecology kept pace with and at many points led the advance, and it is to **J. C. A. Recamier** (1774–1856) that the profession owes the rebirth of the vaginal speculum. Although he had employed the vaginal speculum as early as 1801, it was not until 1818 that Recamier called the attention of his French colleagues to the value of the instrument in the study of diseases of the vagina and cervix. He was not content with exposing the cervix to

[1] T. Gaillard Thomas received his M. D. from the Medical College of the State of South Carolina in 1852; interned at Bellevue Hospital and in the Emigrant Refuge Hospital on Ward's Island, New York; and settled in practice in New York after two years in Europe visiting hospitals. He succeeded Gunning S. Bedford as professor of obstetrics in the University Medical College in 1855; in 1863 was appointed professor of obstetrics and diseases of women and children in the College of Physicians and Surgeons, and in 1881 professor of clinical gynecology. He was attending surgeon to the Woman's Hospital of New York, 1872–1887.

[2] Edmund Randolph Peaslee received his M. D. from Yale Medical School in 1840. The following year he was appointed lecturer in anatomy and physiology at Dartmouth Medical School, succeeding Oliver Wendell Holmes; in 1843 lecturer and later professor of anatomy and surgery in Bowdoin College; in 1851 he became professor of anatomy and physiology in the New York Medical College; in 1853 was transferred to the chair of physiology and pathology, and still later to the chair of obstetrics and diseases of women; in 1874 he became professor of gynecology in the Bellevue Hospital Medical College. He was probably the most scholarly of the American gynecologists of his period.

[3] Alexander Johnson Chalmers Skene was born in Fyvie, Aberdeenshire, Scotland. He received his M. D. from Long Island College Hospital in 1863 and from 1864 until his death held various appointments in that institution—professor of gynecology, dean, and president (1886–1893). He was also professor of gynecology in the New York Post-Graduate Medical School from 1883 to 1886. Many honors were conferred on him, and he was an active member of numerous scientific societies.

[4] William Goodell graduated from Jefferson Medical College in 1854. He won his international reputation through his work at the Preston Retreat in Philadelphia. He was appointed lecturer in obstetrics and diseases of women in the University of Pennsylvania in 1870, professor of diseases of women and children in 1874, and upon his resignation (1894) honorary professor of gynecology.

Sir Charles Mansfield Clarke (1782–1857) published his *Observations of those diseases of females attended by discharges* in 1814–1821 (Parts I and II). In this the author called attention to the general neglect of pelvic diseases and noted that leukorrhea was a symptom and not a distinct disease entity. Another important monograph entitled *Observations on Diseases of the Uterus* was published in 1805 by George Rees (1776–1846). In 1829 **Robert Gooch** published *An account of some of the most important diseases peculiar to women.* **Sir James Y. Simpson** (1811–1870) (Fig. 78), who had had a remarkable training in pathology for his day, succeeded James Hamilton as professor of midwifery at the University of Edinburgh. He discovered the anesthetic power of chloroform and advocated its use in preference to sulphuric ether. He became an enthusiastic student of gynecology, but did not live to witness many

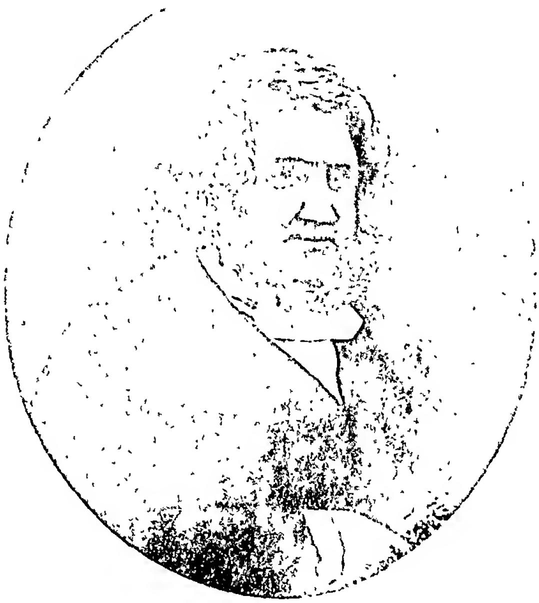

Fig. 78.—Sir James Young Simpson. Frontispiece in *Sir James Young Simpson and Chloroform* by H. Laing Gordon, London, 1897.

improvements in this field as his death occurred before the period of antisepsis. Fleetwood Churchill (1808–1878) became one of the outstanding teachers of midwifery and gynecology in Dublin and in his later years devoted special attention to gynecology.

In 1823 there was read before the Royal Medical and Chirurgical Society of London a paper entitled *Physiological Observations and Experiments* by **James Blundell.** In many ways this proved an epoch-making contribution. Through animal experiments, Blundell had shown the possibility of invading the peritoneal cavity, particularly with reference to diseases of the female pelvis, and concludes with recommending, should necessity require, the following procedures:

"1. A division of both fallopian tubes, and even the removal of a small piece of them, so as to render them completely impervious, a fit addition, apparently, to the Caesarean

endeared himself to his patients and his fellow practitioners. World gynecology will long remember the debt owed to these three ovariotomists of the "old school."

In the late eighties, **J. H. Aveling,** then an acknowledged leader in British gynecology, tells of the steady and at times fierce opposition encountered by gynecologists at the hands of their surgical colleagues and the general profession. Nevertheless, he notes that, despite opposition, progress in gynecology had been consistent. At times unreasoning enthusiasm greatly retarded scientific advance and the "fads" promulgated in many quarters diverted the attention of otherwise sound clinicians. With the passing of each decade of the nineteenth century, advances were clearly defined; there was a growing knowledge of pathology, with correction of earlier misconceptions of pelvic disease. For example, peritonitis *per se* was but poorly understood until 1880, when T. Gaillard Thomas clearly identified so-called "cellulitis" as peritonitis. As the late Sir William Osler in his address[1] at the fourth annual meeting of the American Paediatric Society held in Boston in 1892 said:

> "Perhaps, as specialists, no class in our profession has been more roundly abused for meddlesome work than gynaecologists, yet what shall not be forgiven to the men that, as a direct outcome of the very operative details that have received the bitterest criticism, have learned to recognize tubal gestation, and are today saving lives that otherwise would inevitably have been lost. The benefits the public reap from specialism may be gathered from the fact that in a not much longer period of time I have seen seven specimens of tubal gestation, not removed by the pathologist, but by the gynecologist, with the saving of five lives. The conservatism that branded ovariotomists as butchers and belly rippers is not yet dead among us, and I say it frankly to our shame, that it has not always been professional encouragement that has supported daring advances on special lines. Humanity owes a great debt of gratitude to the devoted men that have striven during the past half century for exactness in knowledge and for practical application in all departments, a debt too great to pay, too great, one sometimes feels, even to acknowledge."

Despite all possible developments in surgical technic, all mastery of the principles of physiology, of a perfect understanding of each and every pathologic manifestation, gynecology would be but a ghost of its present stalwart reality were it not for the beneficent rôle of surgical asepsis. To Pasteur, to Lister and to the bold spirits who courageously followed their teaching, modern gynecology owes, in largest measure, its success. History does not deal with the achievements of the living and at least half a century must elapse ere we may be permitted to evaluate with reasonable accuracy the remarkable progress of the past generation.

[1] Quoted in the *New York Journal of Obstetrics and Gynecology*, vol. i, 1892.

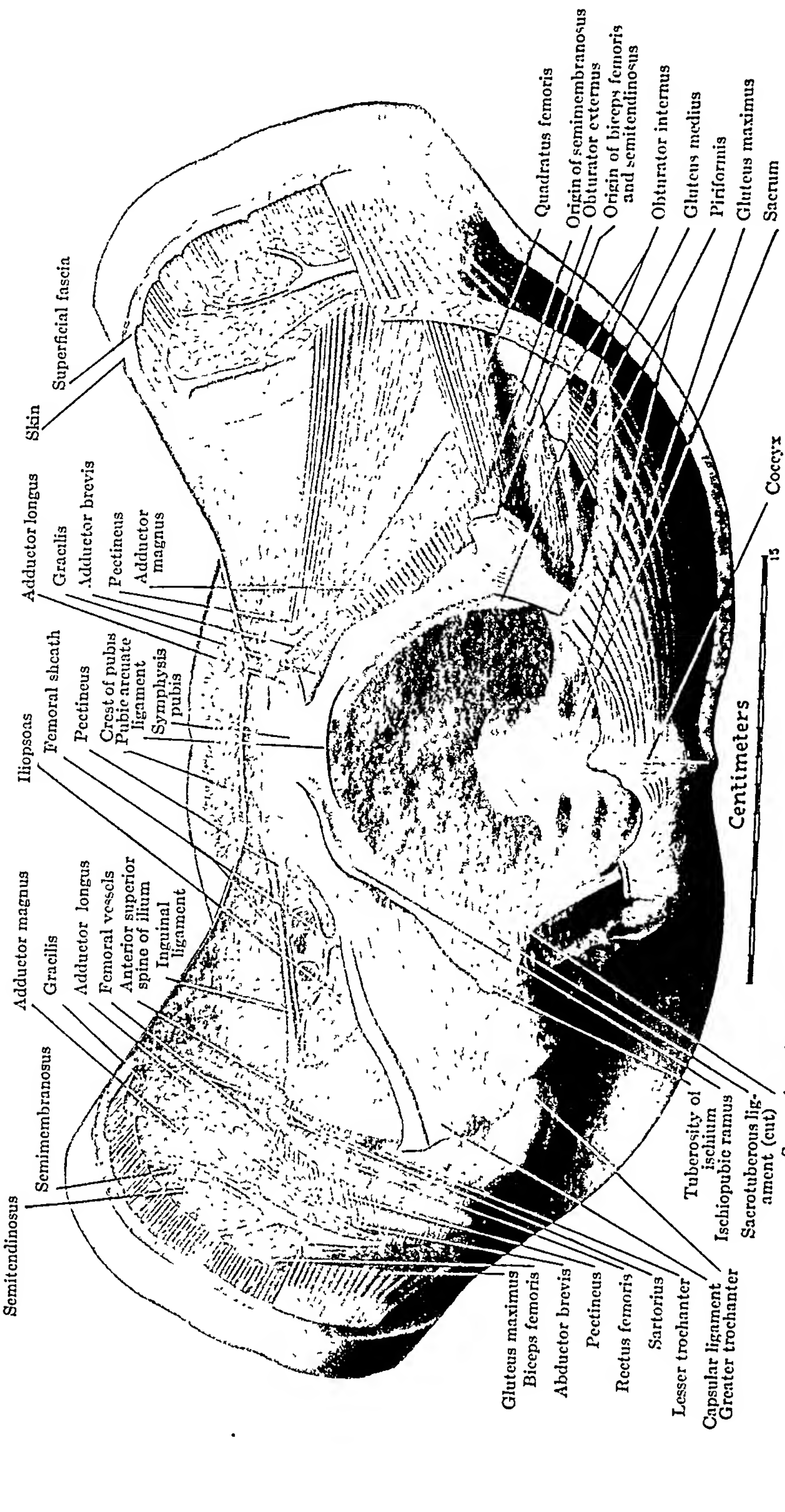

Fig. 79.—The inferior aspect of the female pelvis, showing bones and ligaments, and, on the (subject's) left, the muscles of the thigh and of the buttock.

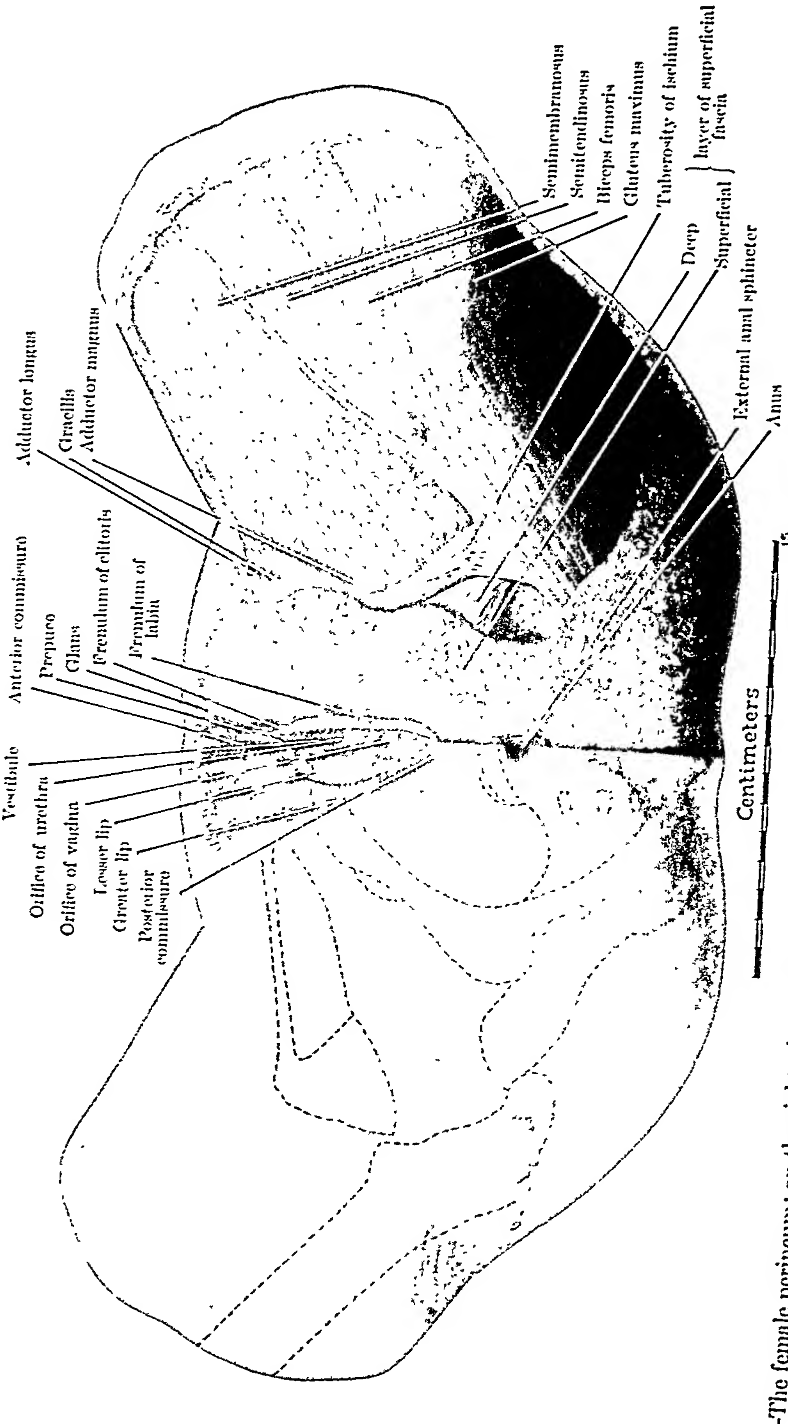

Fig. 80.—The female perineum; on the right, the external genital organs are shown; on the left, the skin has been reflected to show the layers of the superficial fascia and their relations to the urogenital and anal portions of the perineum.

Anal Region

Anal Canal.—The anal canal opens to the exterior in the middle of the anal triangle (Fig. 80). The skin surrounding it is pigmented and thrown into folds, and contains the large circumanal sweat glands. The anus is situated about 2.5 cm. in front of the tip of the coccyx, and forms the truncated end of the funnel-shaped muscular and fascial support, the pelvic diaphragm. To either side of the anal canal and the diaphragm upon which it terminates lies a space termed the ischiorectal fossa (Fig. 81). The superficial fascia over this posterior part of the perineum is remarkable for the considerable amount of fat in its meshes; in the form of two adipose pads, it fills the spaces of the fossae, extending deeply between the ischium and the rectum, on each side of the median line.

Ischiorectal Fossae.—Each fossa (*fossa ischiorectalis*) and the contained mass of fatty connective tissue is prismatic in shape. The fossae are widest and deepest behind, narrowest and shallowest in front, being here encroached upon by the ascending pubic arch. The lateral vertical wall (Figs. 82 and 83) is formed by the ischium, covered by the parietal fascia investing the obturator internus muscle; the medial wall is formed by the diaphragmatic fascial layer which covers the under surface of the levator ani and coccygeus muscles. The apex of the fossa is situated at the line of junction of these fasciae, since, anteriorly, the fossa does not end at the base of the urogenital diaphragm but continues forward between the latter and the pelvic diaphragm, into the urogenital part of the perineum. Posteriorly, the basal aspect of the space is limited by sacrotuberous ligament and the gluteus maximus muscle, above the lower border of which it extends into a posterior recess.

On the lateral wall of the fossa, and above the lower margin of the ischial tuberosity, the fascia of the obturator internus muscle is elevated to form a canal (Alcock's) for the internal pudendal vessels and the pudendal nerve which are coursing toward the urogenital part of the perineum. Originating from them, near the tuberosity of the ischium, the inferior hemorrhoidal vessels and nerves pierce the fascial canal and pass medialward and forward through the fatty connective tissue pad of the fossa to the anal canal (Fig. 81); nerves and veins accompany the arteries.[1]

External Anal Sphincter.—The outer sphincter muscle (*musculus sphincter ani externus*) is a subcutaneous group of skeletal (striated) muscle fibers which surrounds the margin of the anal canal (Fig. 81 *et seq.*). The inner fibers, which form a strong ring, are separated from the nonstriated fibers of the internal sphincter (*m. sphincter ani internus*), the intrinsic cylindrical muscle of the canal, by the levator ani muscle of the pelvic diaphragm. The external sphincter forms an elliptical structure which measures 5 cm. in length and 4 cm. in extreme width; from the rounded ends of the oval collar pass fibers which are attached to the terminal portion of the coccyx behind, and blend with the superficial perineal muscles at the central tendinous point of the perineum in front (page 207).

Anococcygeal Body.—The posterior part of the external sphincter becomes enmeshed in a rather indefinite body of fibrous and muscular tissue, which lies between the levator ani muscle and the coccyx; situated in this position, it serves as a support for the lower part of the rectum and the anal canal.

[1] Arteries and veins, nerves and lymphatic vessels, of the pelvis and perineum are discussed on pages 238 to 250.

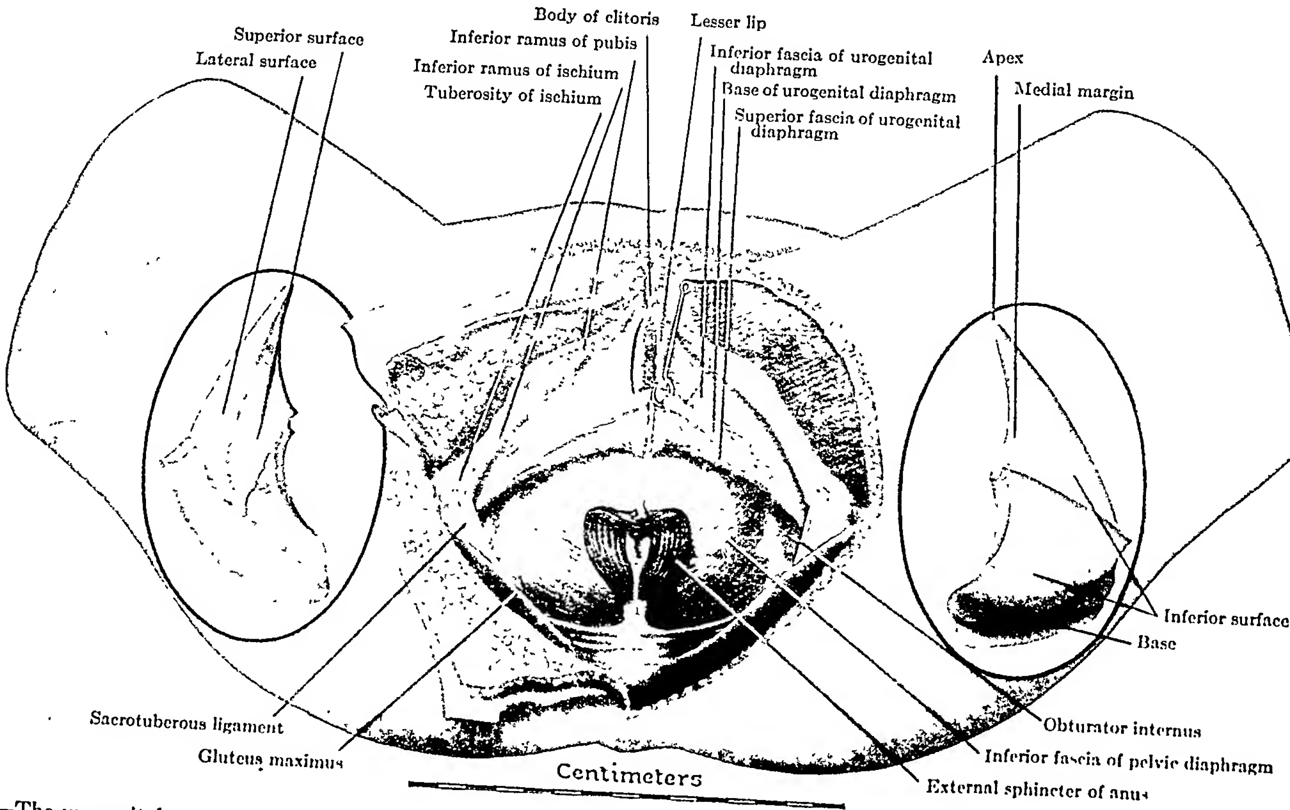

Fig. 83.—The urogenital and pelvic diaphragms, in the female perineum. The more superficial layers have been removed to show the urogenital diaphragm; the latter has been drawn forward, revealing the anterior continuation of the ischiorectal fossa, the superior boundary of which is the pelvic diaphragm. Insets: upper and lower aspects of a plaster cast of the left ischiorectal fossa, showing the extent and shape of the space.

where they blend with labia majora. Here, a short distance in front of the posterior commissure, they are connected by a transverse fold of skin (*frenulum labiorum pudendi;* fourchette); immediately anterior to and above this fold, between it and the posterior limit of the vaginal orifice, lies a shallow depression or fossa (*fossa navicularis*), dorsally placed in the vestibule. The labia consist of a hair-free integument which resembles mucous membrane and an underlying vascular connective tissue which is part of the superficial fascia of the perineum.

Clitoris.—Only a portion of the small body and the glans of the clitoris are visible when the labia minora are retracted; otherwise they are concealed by the labia and the mons pubis. The clitoris will be further described in connection with the contents of the superficial perineal compartment (page 206).

Vestibule.—The vestibule (*vestibulum vaginae;* pudendal cleft, urogenital space or fissure) represents the urethral groove of the sexually indifferent embryo, the unfused margins of which come to form, in the female, the labia minora flanking the original cleft. The vestibule opens below onto the surface of the perineum between the labia. It is a fissure elongated anteroposteriorly; when the lips are drawn apart it assumes a triangular shape. The apex of the vestibule ends at the clitoris, and its basal part, including the space of the fossa navicularis, is bounded by the frenulum of the labia. The urethral orifice opens into its anterior, the vaginal orifice into the posterior, part; on each side enters the minute duct of the corresponding greater vestibular gland. Just in front of the urethral opening is a smooth triangular area of mucous membrane limited by the clitoris anteriorly and the labia minora laterally.

Orifice of Urethra.—The external orifice (*orificium urethrae externum;* urinary meatus) is a small opening behind the glans of the clitoris and in the middle line of the vestibule. Although its shape is variable, it ordinarily assumes the form of a short sagittal cleft; when opened its diameter is about 4 mm. The mucous membrane around the margin is somewhat elevated and puckered; the papillary projection thus outlined is usually prominent enough to be palpable. Just without the urethral orifice are several minute cryptlike openings, termed the para-urethral ducts (*ductus paraurethrales*). Skene's ducts, of clinical importance because so often foci of gonorrheal infection, are two small paired glands approximately 1 cm. in length, situated beneath the floor of the urethra, the orifices of the glands presenting bilateral almost microscopical openings at the urethral meatus; these glands are the rudimentary homologue of the prostate gland in the male. They are similar histologically to the numerous and separate mucous glands of the urethra, save in the manner in which they may group themselves to employ a common duct.

Orifice of Vagina.—The vaginal orifice (*orificium vaginae*) opens medially into the vestibule, below and behind the urethral orifice. Its appearance is wholly dependent upon the condition of the hymen.

Numerous small mucous glands, the lesser vestibular glands (*glandulae vestibularis minores*) open upon the smooth surface of the vestibular mucous membrane between the urethral and vaginal orifices.

Hymen.—The hymen is typically a thin vascular fold of mucous membrane attached around the circumference of the entrance into the vagina.

or extravasated urine dissects its way, other routes being closed through the strength of fascial continuities and attachments.

The compartment contains the erectile or cavernous bodies of the clitoris and their investing muscles; in addition it is traversed by the vessels and nerves[1] (Fig. 81) which supply these structures, and by those which ultimately leave the space to reach the integument and the subcutaneous tissue of the labia. Through the compartment, in vertical direction and in the median plane, pass the terminal portions of the urinary and the genital tracts, partially subdividing the space into two.

Erectile Tissue.—It has already been stated that the only portions of the clitoris visible when the labia are retracted are the small conical end of the glans and the short body, the latter noticeable only as a low vertical ridge in the integument covering the lower part of the symphysis pubis. The other constituents of the erectile tissue, with their investing musculature, are housed in the superficial perineal compartment and are brought into view only when the deep layer of the superficial perineal fascia is removed (Fig. 81). The erectile bodies are composed of an intricate plexiform arrangement of vascular channels confined in definite masses by tough fibrous tunics. When incised, the cut surface displays channels in the form of cavities, and hence the tissue is referred to as cavernous.

Together the cavernous or erectile bodies form the clitoris (Figs. 81 and 82), and they are homologous, though in reduced and modified form, to the components of the penis in the male. The constituent parts of the female organ are the paired corpora cavernosa and the paired vestibular bulbs—the latter joined anteriorly to the glans. Each *corpus cavernosum clitoridis* corresponds to a *corpus cavernosum penis* in the male, but is much smaller; and, duplicating the condition in the male, the two corpora cavernosa unite in front to form the body of the clitoris (*corpus clitoridis*) and diverge behind as the crura (each a *crus clitoridis*). The vestibular bulb (*bulbus vestibuli*) of either side corresponds developmentally to a lateral half of the urethral bulb (*bulbus urethralis* of *corpus cavernosum urethrae*) in the male, but with the difference that the halves in the female remain separate and enclose the space of the vestibule.

The laterally placed corpora cavernosa, through their union anteriorly, form the small unpaired cylindrical body of the clitoris. The body, which measures 2 to 3 cm. in length, is bent upon itself and tapers somewhat distally, where it is covered by the glans. Although the two cavernous bars are enclosed in a dense fascial coat (*fascia clitoridis*) some degree of separateness between the symmetrical halves is effected by the clitoridal septum (*septum clitoridis*). As the body of the clitoris hangs down in front of the pubic symphysis it is provided with a suspensory ligament (*lig. suspensorium clitoridis*) which passes upward from it to the symphysis and onto the anterior abdominal wall. Behind, the two corpora cavernosa become completely separate as the crura, and are attached to the inner aspect of the pubic arch, or, more specifically, to the rami of the ischium and the pubis. Each is longer than the body, measuring about 4 cm. in length.

The rounded tubercle termed the glans, which constitutes the free extremity of the clitoris, possesses like the homologous male organ, a frenum and a prepuce (page 203). It is not, however, traversed by the urethra.

[1] Vessels and nerves; pages 238 to 250.

The two transverse muscles serve to fix the central point, and are the stay around which the deep layer of the superficial fascia turns upward to join the inferior fascia of the urogenital diaphragm and to close the superficial compartment behind.

Each ischiocavernosus muscle (*m. ischiocavernosus; erector clitoridis*) is smaller than the corresponding muscle of the male. It is an elongate oblong muscle, which fits groovelike over the unattached surfaces of the crus clitoridis (right half of Fig. 82). It is situated along the lateral boundary of the perineum, where it arises from the medial aspect of the ischial ramus close to the tuberosity and about 2 cm. behind the origin of the crus; the fibers insheathe and insert into the medial and inferior surfaces of the crus clitoridis extending as far forward as the body. The two muscles serve to compress the crura and by thus retarding the egress of blood, assist in producing erection of the clitoris.

In the male perineum the bulbocavernosus muscle is a single structure; from an origin at the central tendinous point the muscle spreads over the bulb of the urethra uniting on the superior aspect of the corpus cavernosum urethrae. In the female, on the contrary, the bulbocavernosus muscle (*m. bulbocavernosus; sphincter vaginae*) is halved symmetrically by the vestibule, and each half is closely adapted to the lateral surface of a vestibular bulb, the bulbs representing an unfused, and therefore bifid, corpus cavernosum urethrae of the male. The fibers of both halves take origin from the central tendinous point, beneath the posterior labial commissure; they separate behind the vaginal orifice to pass forward on the walls of the vestibule; converging toward the midline and narrowing into slender fasciculi they extend in their insertion as far anteriorly as the dorsum of the body of the clitoris. They, too, act as constrictors of the erectile tissue.

Vestibular Glands.—The greater vestibular glands (*glandulae vestibulares majores*; Bartholin's glands) are the homologues of the bulbo-urethral (Cowper's) glands of the male. They are paired round or oblong bodies, attaining a length of about 1 cm. in their greatest diameter. They are placed at the posterior ends of the vestibular bulbs, into which their lobules may project. Their long simple ducts, which convey the mucous secretion, open into the vestibule, one on each side of the fossa navicularis; the orifices are visible to the naked eye just below the hymen near the middle of the vaginal orifice.

The Triangular Space.—The bulbocavernosus muscle of each side forms the medial boundary of a small triangular area, on the roof or superior aspect of which may be seen the inferior fascia of the urogenital diaphragm. The lateral boundary is formed by the ischiocavernosus muscle (Fig. 81); posteriorly lies the superficial transverse perineal muscle; the floor is formed by the deep layer of the superficial fascia. Running forward and medialward in the space are the posterior labial vessels and nerves and the transverse perineal vessels.

Urogenital Diaphragm.—The deep fascia of the urogenital part of the perineum, like the superficial fascia of the same region, is double-layered. But, whereas the two layers of the superficial fascia are applied closely to each other, the two layers of the deep are separated by important intervening structures (Fig. 82) and constitute the fibrous plates of the urogenital diaphragm (Fig. 83). The lower one of these is termed the inferior, the

upper, the superior fascia of the urogenital diaphragm (*diaphragma urogenitale;* triangular ligament or urogenital trigone).

The two aponeurotic laminae (Fig. 84) are attached to the inner aspect of the pubic arch; they are blended together in front to form a sharp transverse ligamentous band, and behind, they produce an evenly rounded margin. The two fasciae enclose a slitlike pouch which is the second or the deep compartment of the perineum (opened in Fig. 84). This pouch contains the sphincter muscle, surrounding the membranous part of the urethra, and the deep transverse perineal muscle; it is around the latter that the component layers of the diaphragm curve and join each other posteriorly. The entire diaphragm, then, is a strong musculomembranous partition, of trapezoidal outline, stretched almost horizontally across the anterior half of the pelvic outlet. It is broader in the female than in the male, owing to the greater width of the pubic arch; it is less strong in the female, however, since it is pierced by the vaginal canal. The base, which is directed toward the anal part of the perineum, is drawn backward toward the midline, at the central tendinous point; the truncated apex is directed toward, but does not reach, the inferior aspect of the pubic symphysis. The diaphragm measures about 12 cm. across the wide basal portion, and 5 cm. from base to apex; but the maximum depth of the enclosed space is less than 2 cm., and the perpendicular courses of the vagina and of the urethra through the compartment are correspondingly short.

Inferior Fascia of the Urogenital Diaphragm.—The more superficial of the two deep fascial layers of the urogenital region is known as the inferior fascia of the urogenital diaphragm (*fascia diaphragmatis urogenitalis inferior;* anterior, inferior, or superficial layer of the triangular ligament; or inferior triangular ligament). In being interposed between the cavernous tissue and its musculature inferiorly, and the urethral sphincter superiorly, the fascia is at once the roof of the superficial, and the floor of the deep, compartment (compare Figs. 82 and 84). Its shape and dimensions are those of the diaphragm previously described, of which it is the lower layer. It lies in the same plane as the rami at the pelvic outlet, its inferior surface facing somewhat anteriorly. The lateral margins are attached to the medial surfaces of the inferior rami of the ischium and the pubis, above the level of the attachment of the crura clitoridis; the median portion of the base is sent backward in the form of a fibrous projection to join the tendinous muscular attachments at the central point of the perineum; it is continuous in the basal part with the deep layer of the superficial fascia below (right half, Fig. 82) and the superior fascia of the urogenital diaphragm above (left half, Fig. 84); these continuities close the perineal compartments behind. The blunted apex is directed forward and unites with superior fascial layer to form a ligamentous band, the transverse ligament of the pelvis (*lig. transversum pelvis;* transverse perineal ligament) which passes from one side of the pubic arch to the other. On either side it blends with the arcuate pubic ligament (*lig. arcuatum pubis;* inferior pubic or subpubic ligament) except in the center where the dorsal vein of the clitoris (Fig. 84), emerging from the superficial perineal compartment, passes upward and backward through an oval opening between the two ligaments to reach the pudendal venous plexus behind the pubic symphysis within the pelvic cavity (Fig. 86).

The inferior fascia is not an unbroken layer. It is pierced in the median plane by the urethra and the vagina; the point of perforation by the urethra

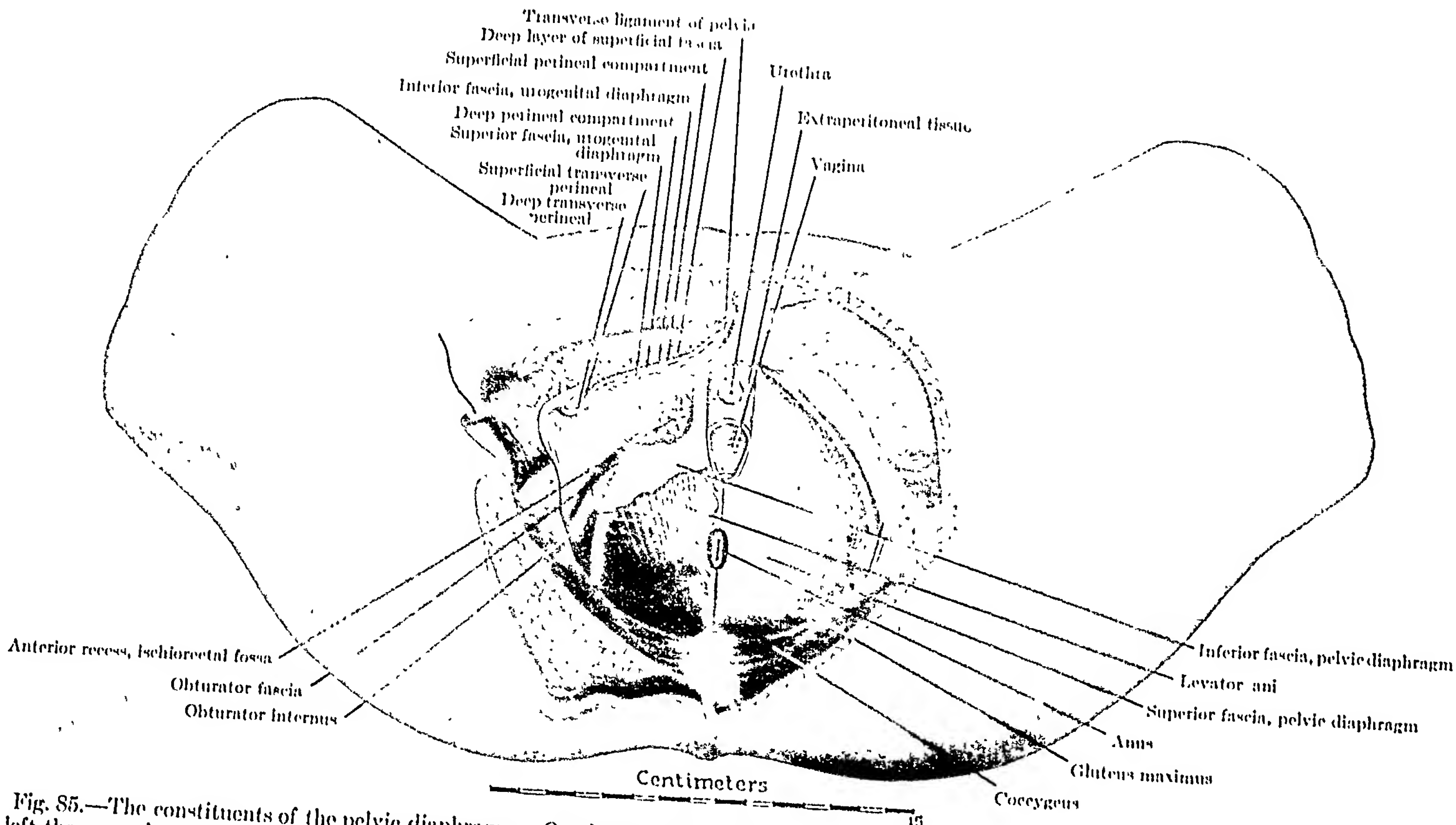

Fig. 85.—The constituents of the pelvic diaphragm. On the right, the inferior fascia of the pelvic diaphragm and the levator ani are shown; on the left the musculature has been removed to show the superior fascial layer of the diaphragm. Some fatty tissue remains in the anterior recess of the right ischiorectal fossa.

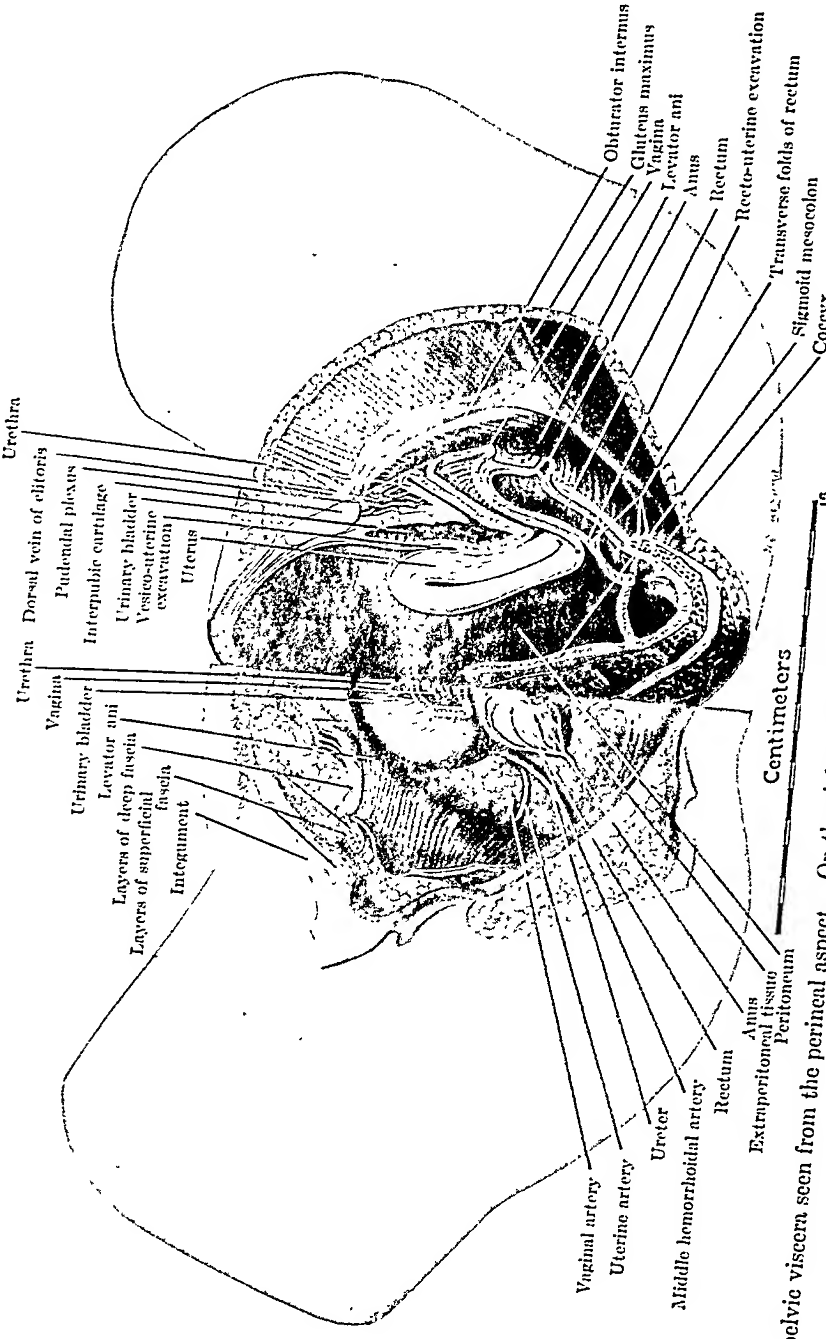

Fig. 86.—The pelvic viscera seen from the perineal aspect. On the right half the levator ani muscle has been turned outward to show the viscera; on the left it is intact.

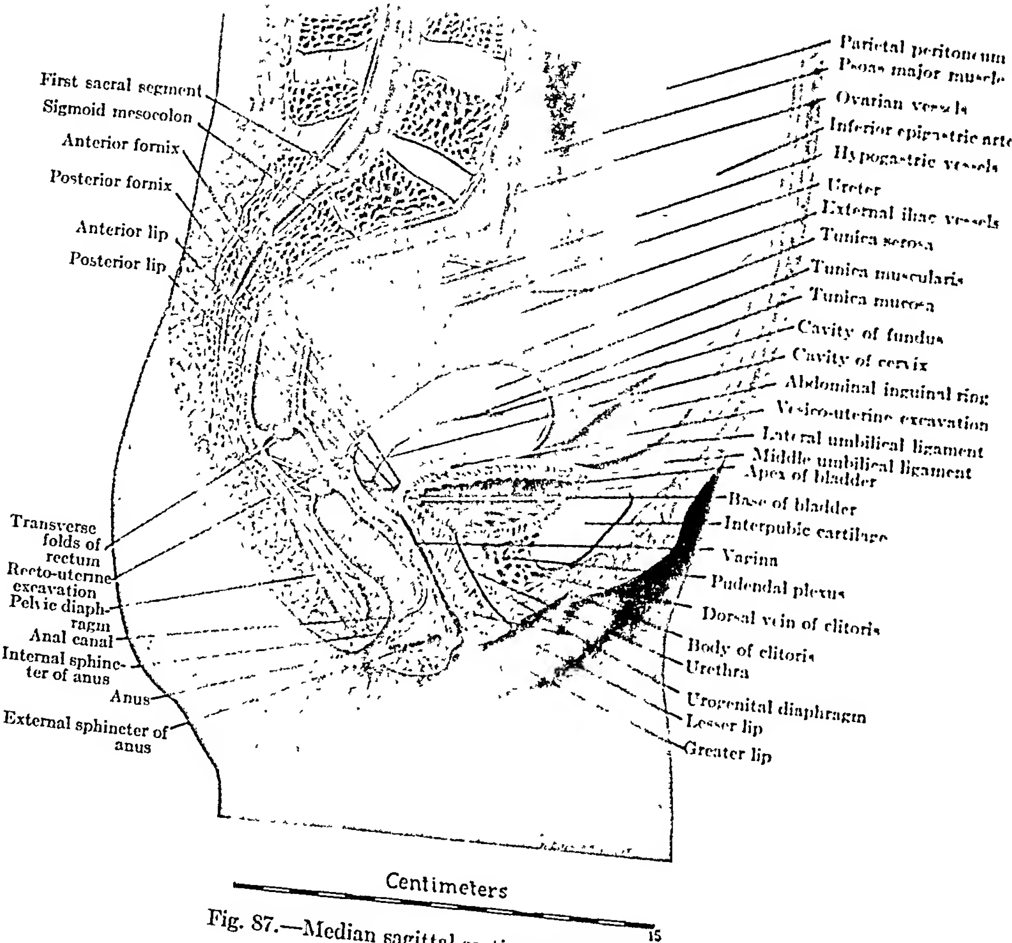

Fig. 87.—Median sagittal section of the female pelvis.

from which it is continued lateralward as the anterior layer of the broad ligament; the shallow troughlike recess thus formed is the vesico-uterine excavation (*excavatio vesico-uterina;* uterovesical pouch). The peritoneal layer next covers the fundus of the uterus, investing all of the posterior uterine, and a small upper segment of the vaginal, wall; from the uterus it is again extended lateralward to form the posterior layer of the broad ligament of the uterus. From the uterus and the ligament the peritoneum passes to the front of the rectum, forming a deeper sac, the recto-uterine excavation (*excavatio recto-uterina;* recto-uterine pouch, culdesac or pouch of Douglas). The peritoneum reaches the rectum at the junction of its lower and middle thirds; in the middle third it covers only the front of the tube, while in the upper third it clothes the sides as well; the layers of the two sides then meet above to form a mesenteric support for the sigmoid colon. In partially investing the rectum the peritoneum forms paired pouches, the pararectal fossae bounded on each side by a crescentic fold of peritoneum, the recto-uterine fold (*plica recto-uterina;* fold of Douglas) which corresponds to the sacrogenital fold in the male, and contains the uterosacral ligament.

Extraperitoneal Tissue

This layer of subserous areolar tissue (*tela subserosa;* extra-, sub-, or retroperitoneal tissue) forms a dense cobweb-like packing containing a varying amount of fat, which intervenes between the fascia on the inner surface of the abdominal and pelvic musculature and the peritoneum which lines the contained cavity. In the abdominal cavity proper the tissue is carried forward between the layers of the supporting mesenteries to the viscera, and within it course the splanchnic branches of the vascular and nervous systems. In general, on the abdominal parietes the peritoneum is rather closely applied to the fascia, and consequently the subserous tissue forms a relatively thin layer. In the pelvis, however, the peritoneum is reflected from the wall to the organs at a level considerably higher than the point at which the parietal fascia is continued medialward on the upper surface of the pelvic diaphragm (Fig. 95); and the considerable subperitoneal space thus produced is filled with the adipose areolar tissue. Here the tissue forms a bed around the pelvic organs over which the peritoneum is draped. It encloses much of the rectum, which possesses only a partial peritoneal covering; it forms a bed for the bladder, investing the organ below and behind; it extends upward along the sides of the uterus, between the layers of the broad ligament, there forming the connective tissue matrix, or parametrium, in which are embedded the uterine tubes and the ovaries, with their vessels and nerves.

Pelvic Viscera

The female pelvis minor contains the following viscera: the rectum and the sigmoid colon; the urinary bladder, the urethra, and the ureters; the uterus, the vagina, the uterine tubes and the ovaries. We shall be concerned particularly with the last-named group, the genital organs; the pelvic portions of the digestive tube and of the urinary system may first be dispatched in summary statement.

Urinary and Digestive Organs.—*Urinary Bladder, Urethra, and Ureters.*—The urinary bladder (*vesica urinaria*) is situated in the anterior part of the pelvic cavity, behind the bodies of the pubic bones, and in front of the vagina

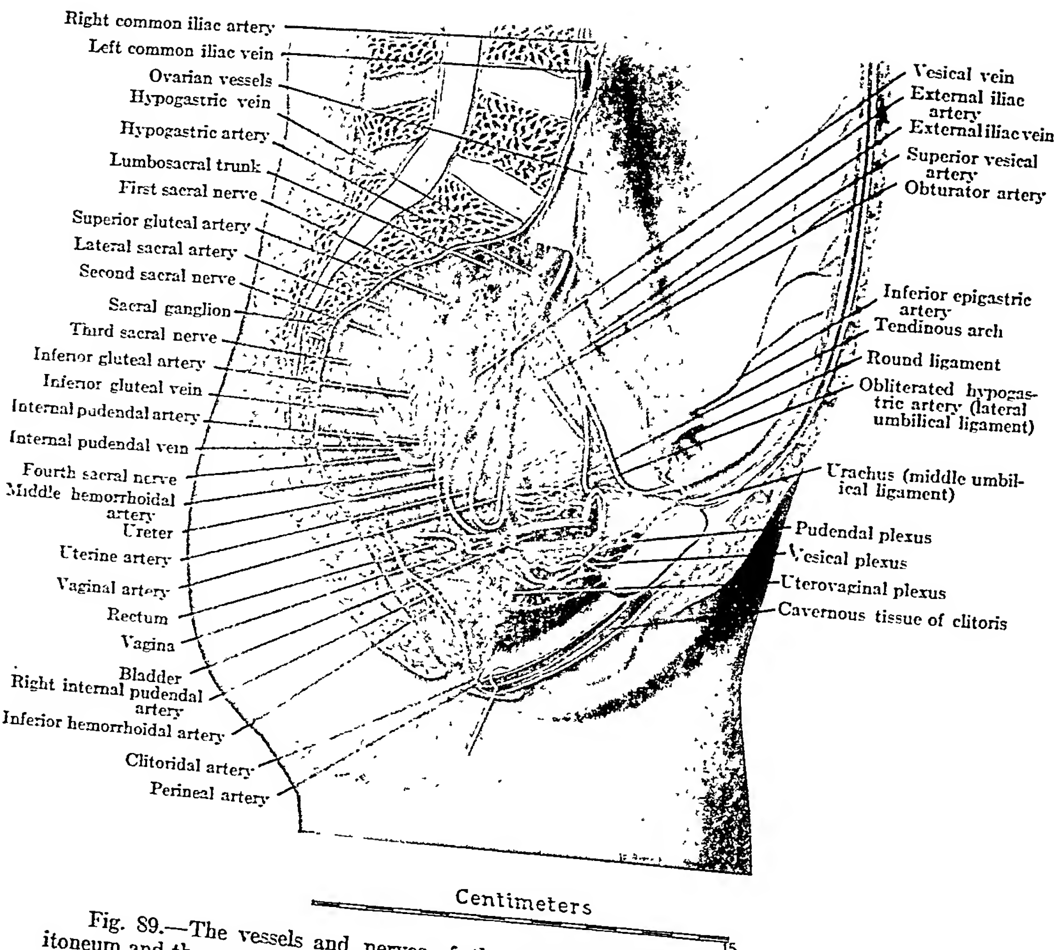

Fig. 89.—The vessels and nerves of the left half of the female pelvis. The peritoneum and the extraperitoneal fatty tissue have been removed, and the viscera partially cut away.

by the two anal sphincters; the internal one (*m. sphincter ani internus*) represents a considerable thickening of the circular musculature of the anal wall, while the external sphincter (*m. sphincter ani externus*) is a muscular collar situated on the external surface of the pelvic diaphragm in the fatty tissue of the ischiorectal fossae (Fig. 81).

Genital Organs.—*Uterus.*—The uterus (*uterus;* womb) is an unpaired, hollow, muscular organ, situated in the middle of the pelvis minor, between the bladder in front and the rectum behind. It is partially invested by peritoneum, and is lined with mucous membrane. The uterine tubes enter its upper portion on either side, and its cavity is continued into that of the vagina in the middle line below. The ova discharged from the ovaries find their way into the infundibulum of the uterine tubes, through which they pass to the uterus. Should fertilization occur, the ovum becomes implanted there and undergoes prenatal development.

The uterus in the virgin (Fig. 88) is pear shaped and somewhat flattened from before backward. The measurements are: length, 7.5 cm.; width, 5 cm.; thickness, 3 cm. It is divisible into three portions: a base or fundus; the main portion, termed the body or corpus; and the smaller lower extremity, the neck or cervix, which projects into the vagina. The cervix is marked off from the corpus by a slight constriction, the isthmus.

The fundus (*fundus uteri*) is that part of the dome-shaped uppermost end of the organ which lies above a transverse line drawn between the points of entrance of the uterine tubes; it is broad in its transverse diameter, and convex in all directions. At the junction with the fundus, the uterine tubes leave the lateral margins as the so-called horns or cornua. The corpus narrows as it approaches the cervix and has, then, a somewhat triangular outline when seen from the front or from the side. The corpus (with the fundus) possesses two surfaces, an anterior and a posterior, and two margins, right and left. The anterior (also referred to as ventral or inferior) looks downward and forward, resting upon the bladder (Figs. 87 and 94), and hence is better termed vesical (*facies vesicalis*); it is slightly concave in nulliparae, and covered by visceral peritoneum, which, at the junction of the body and the cervix, is reflected to the upper aspect of the bladder, the vesico-uterine excavation lying in the interval. The posterior (dorsal or superior) surface is in contact with the mesenterial portion of the digestive tube and hence is termed intestinal (*facies intestinalis*). It is markedly convex; the peritoneum extends downward beyond the body to invest the cervix, from which it is carried over to the front of the rectum, the space thus enclosed being the recto-uterine excavation. Each lateral margin (*margo lateralis*) of the uterus extends from the origin of the uterine tube to the pelvic floor; it is devoid of peritoneum, since it gives attachment to the diverging layers of the broad ligament. The round ligament of the uterus arises at a point just in front of origin of the uterine tube, and the uterine and ovarian vessels are situated below and behind it; all of these structures lie between the apposed layers of the broad ligament, as the latter extends toward the wall of the lesser pelvis.

The cervix (*cervix uteri*) is the narrower cylindrical segment of the uterus. It is continuous above with the inferior end of the corpus at the constricted isthmus; below, its tapering extremity projects into the upper end of the vagina (Fig. 87). The cervix is thus divided by its relation to the surrounding

tudinal fold from which numerous secondary folds are sent off obliquely lateralward and upward—the similarity to the branchings of a tree suggesting the older term, *arbor vitae uterina*.

STRUCTURE OF UTERUS.—The uterine wall (Fig. 87) is thickest in the fundus and in the posterior wall of the corpus, and thinnest in the cervix. It is composed of three chief layers—the outer serous coat (*tunica serosa*), the middle muscular coat (*tunica muscularis*), and the lining mucous membrane (*tunica mucosa*)—which constitute, respectively, the *perimetrium*, the *myometrium*, and the *endometrium* (Fig. 98, D).

The serous layer, or visceral peritoneum, consists of mesothelial cells, and is attached to the subjacent muscular coat through the medium of a thin stratum of connective tissue—firmly over the surfaces of corpus and fundus, less so over the posterior aspect of the cervix, where it may be stripped away without injury to the underlying structures. This subserous coat, the parametrium, is well developed at the lateral margins of the uterus where it goes directly into the broad ligaments, to become continuous with the extraperitoneal tissue of the pelvic wall and floor. It will be recalled that while the serous layer (peritoneum) invests the anterior surface of the uterus down to the level of the internal orifice, on the posterior surface it descends upon the wall of the vagina.

The muscular layer forms the major part of the bulk of the uterus; it is firm and dense of texture, and resistant to incision. Microscopically the layer consists principally of interlacing bundles of smooth muscle fibers (unstriped, nonstriated, plain, or involuntary muscle of various texts): the fibers are united by connective tissue in which elastic fibers are abundant. Although the bundles of muscle fibers are not disposed in definitely regular layers in the fundus and the corpus, it is possible nevertheless to distinguish three general strata. The outer muscular coat is thin and imperfect, and in it the course of the fibers is mainly longitudinal; they are continuous with those of the uterine tubes, and enter also the broad and the round ligaments. The middle coat is very broad, and is the chief constituent layer of the myometrium; its fibers are circularly arranged; because of the number of blood vessels within it, the layer is known as the *stratum vasculare*, while the overlying superficial layer is termed the *stratum supravasculare*. The innermost bundles are longitudinal (and oblique) in their course, and constitute a thin third stratum, which is regarded as a greatly hypertrophied *lamina muscularis mucosae*, comparable in topography to that present in other hollow organs. In the cervix the three layers are somewhat more distinct.

The muscle fibers increase in size and probably also in number during the first half of pregnancy, and because of the hypertrophy, the uterus never regains its virginal proportions.

The mucous membrane or inner layer is smooth except during menstruation (see Chapter VI). In the fresh specimen of the resting organ it is very vascular, dull red in color, and soft in consistence. It is smooth in the corpus (and fundus), but thrown into an arrangement of feather-like folds in the cervix. The mucous membrane lines the uterine cavity; at the fimbriated extremities of the uterine tubes it becomes continuous with the peritoneum, and, at the external uterine orifice, with the lining of the vagina. The mucous membrane (Fig. 98, F) of the fundus and the corpus is clothed with a layer of simple columnar epithelium which sends tubular pits, the uterine glands, into an underlying *tunica propria*. Areas of the epithelium are ciliated, a condition which is said to be typical of the period of sexual maturity, and to persist for a period of eight or ten years after menopause. The mouths of the numerous uterine glands (*glandulae uterinae*) are large enough to be visible with a hand-lens as minute openings; microscopically, they are observed to be tubular prolongations from the surface of the endometrium; as simple or somewhat tortuous and bifurcated invaginations of the epithelial layer, they extend perpendicularly as far as, or may penetrate, the muscular stratum to a slight extent, becoming lodged between adjacent bundles of muscle. They are embedded in an abundant stroma of cellular areolar tissue, or tunica propria, which resembles closely that of the digestive tube. Blood vessels form a rich network of capillaries, and lymphatic vessels anastomose to produce a widemeshed plexus in this layer.

The mucous membrane of the cervix differs markedly from that of the corpus, in the possession of a foldlike formation on its anterior and posterior walls; between the oblique ridges or rugae (*plicae palmatae*) are grouped the cervical glands (*glandulae cervicales uteri*) (Fig. 98, I).

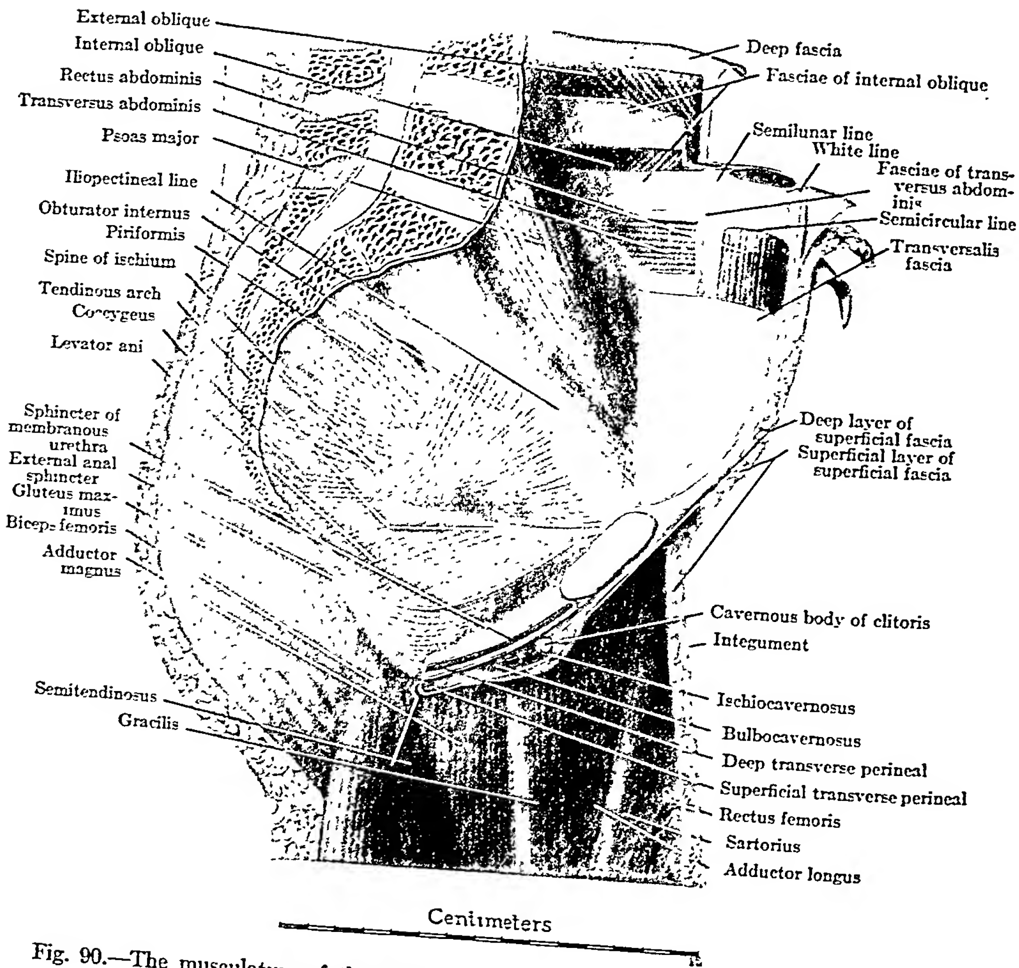

Fig. 90.—The musculature of the female pelvis; the muscles of the abdominal, gluteal, and medial femoral regions are also shown.

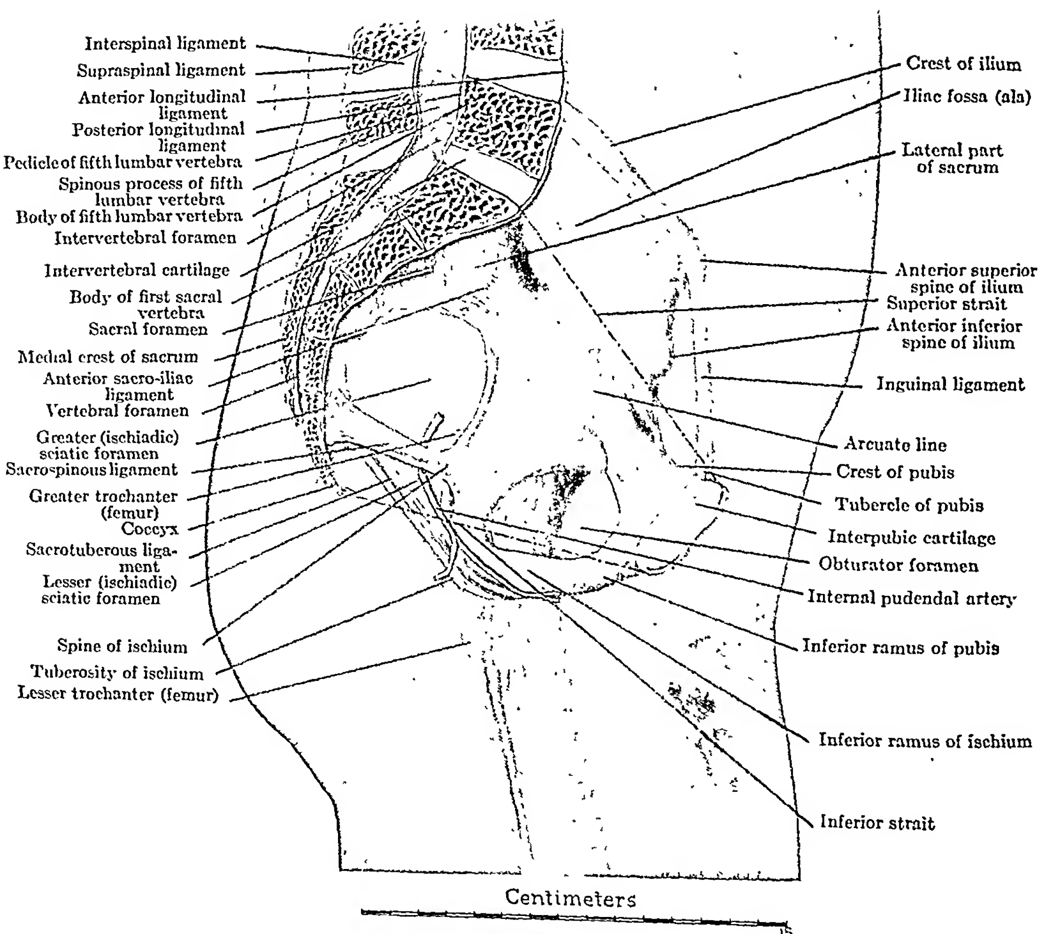

Fig. 91.—The female bony and ligamentous pelvis, viewed in median section.

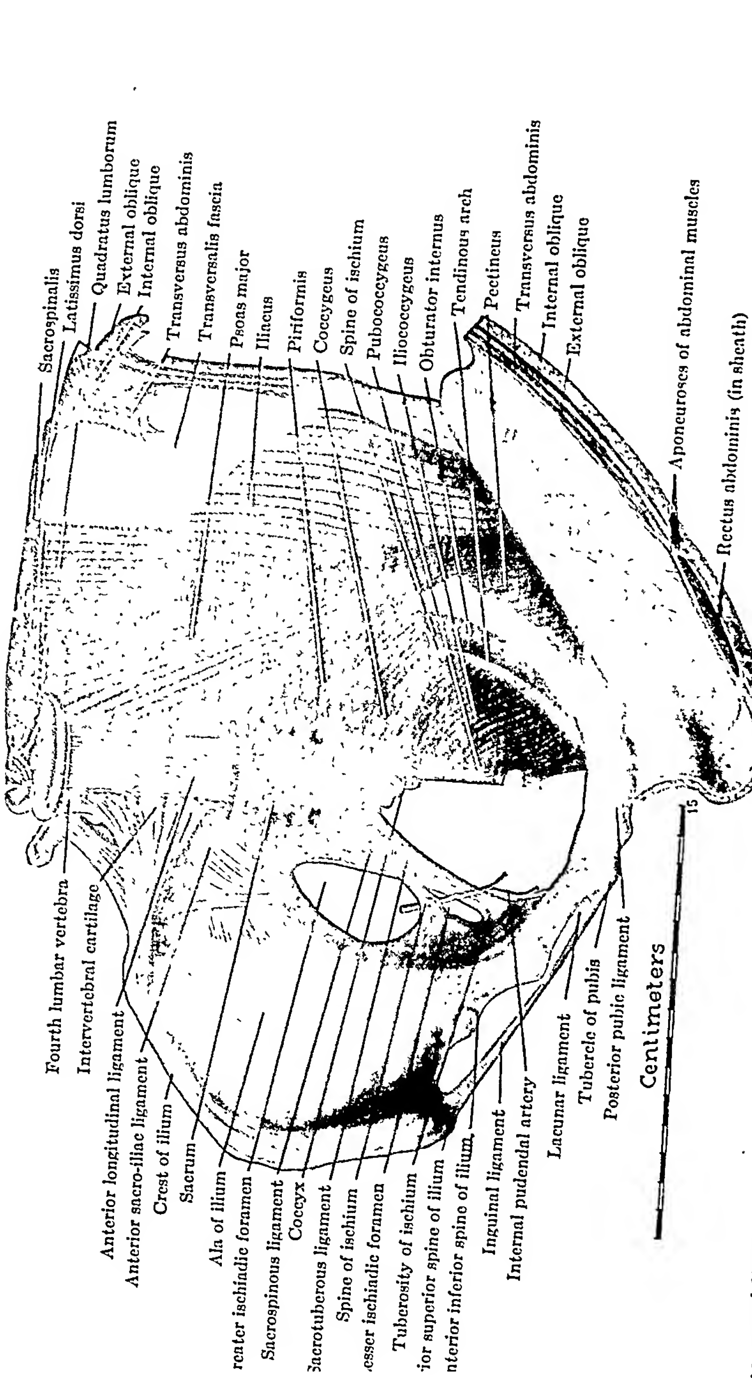

Fig. 92.—The bony and ligamentous pelvis seen from above and in front. The dorsal axial and the anterolateral abdominal muscles are also shown.

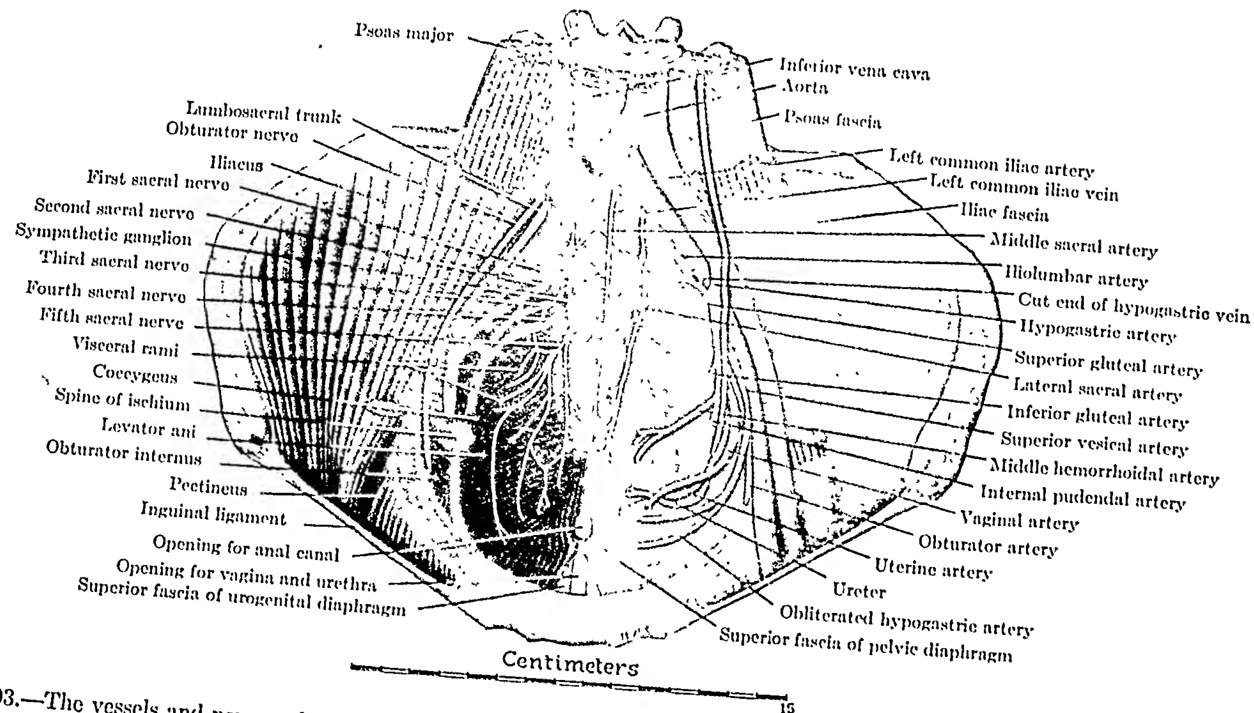

Fig. 93.—The vessels and nerves of the female pelvis. On the left half the fascia is intact, on the right it has been removed.

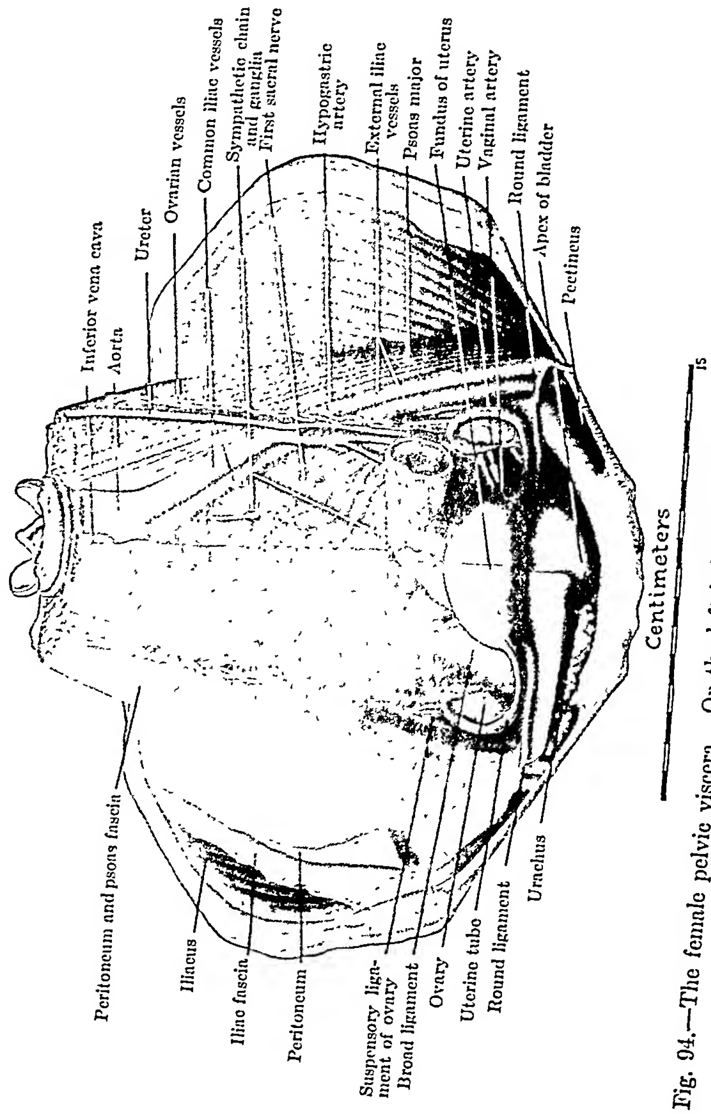

Fig. 94.—The female pelvic viscera. On the left half the peritoneum and fascia have been removed.

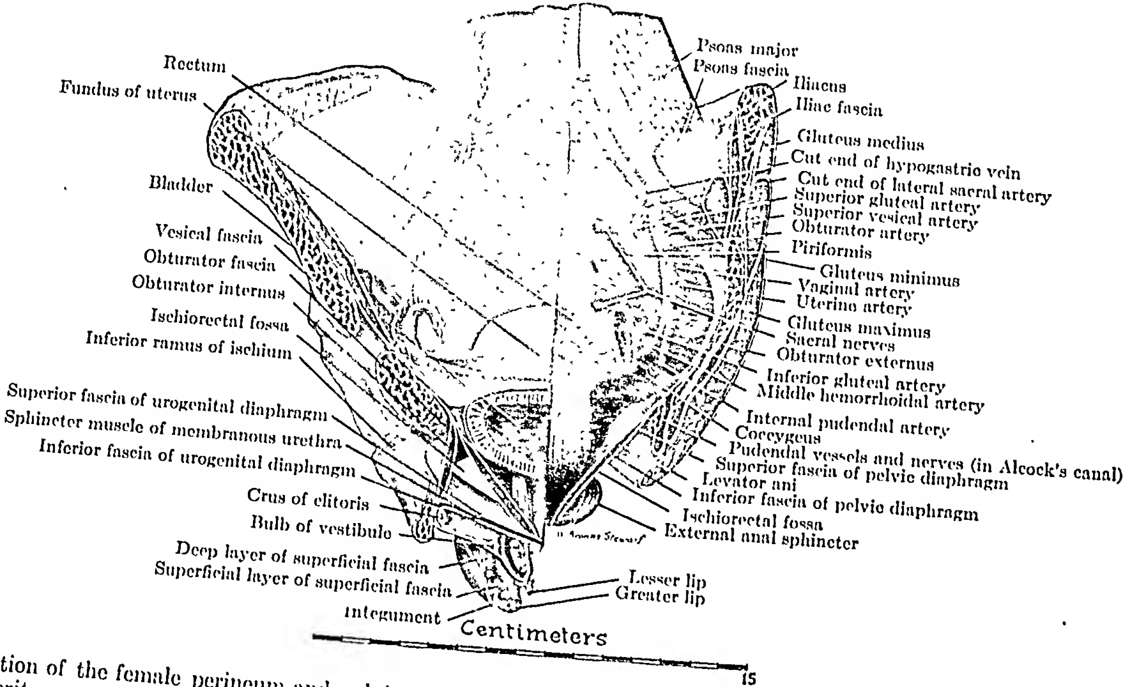

Fig. 95.—Coronal section of the female perineum and pelvis, on the left through the anal, on the right the urogenital, part of the perineum. On the right the peritoneum and the fascial layers are intact; the superficial fatty tissue has been removed from both ischiorectal fossae.

characteristic structures. Shortly after the primitive streak and the notochord have become clearly defined the ectoderm in the midbody region, cephalic to Hensen's node, becomes markedly thickened as compared with the rest of the superficial ectoderm. This thickening, known as the *neural plate*, almost immediately becomes folded into a longitudinal groove which

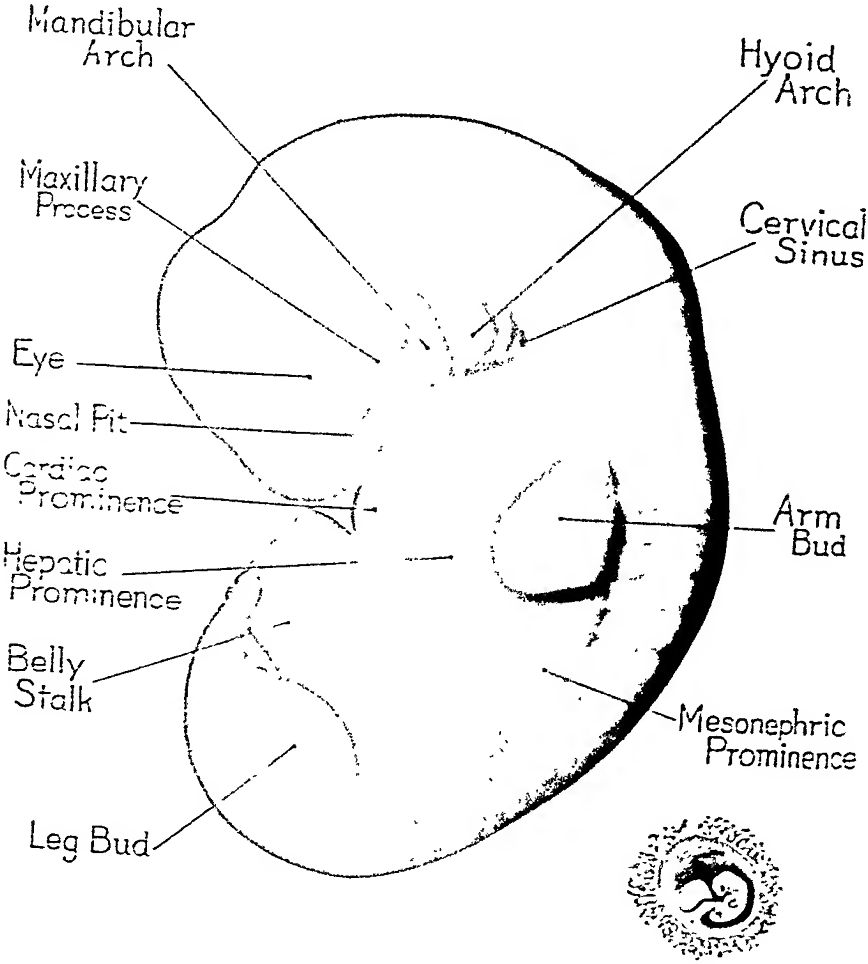

Fig. 178.—Human embryo of about five weeks' fertilization age. Retouched photograph (× 15) of embryo No. 6502 in the Carnegie collection; C. R., 6.5 mm. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

heralds the formation of the central nervous system (Fig. 174). With the establishment of the neural groove, landmarks begin to appear with rapidly increasing clearness. The neural folds in the anterior region are of much greater size than they are farther caudad. This condition foreshadows the differentiation of the neural tube into a conspicuously enlarged anterior portion, the brain, and a more attenuated posterior portion, the spinal cord.

With the exception of the ovarian, the sigmoidal and the superior mesenteric arteries, the vessels supplying the pelvic organs and parietes arise within the pelvis minor from the hypogastric division of the common iliac; the corresponding veins follow comparable courses in leaving the organs. The ovarian arteries, however, arise from the aorta at the level of the kidneys, and the ovarian veins enter the inferior vena cava on the right side and renal vein on the left. In general, the major lymphatic drainage follows that of the veins, into groups of pelvic lymph glands associated with the large arteries and named accordingly. The ovarian drainage is principally into glands along the aorta. The perineum and the pelvic parietes receive their innervation mainly from sacral nerves; but the pelvic viscera are supplied by nerves not only of sacral origin but by thoracolumbar sympathetic branches as well.

Arteries.—The hypogastric arteries (Figs. 89 and 93) are the principal vessels supplying blood to the walls and the viscera of the pelvis, the external organs of generation in the perineum, and the musculature of the buttocks and of the medial side of the thighs. Each hypogastric artery (*a. hypogastrica;* internal iliac) is the medial terminal branch of the corresponding common iliac: it arises at the bifurcation of the latter, opposite the lumbosacral articulation. It passes downward and backward in the pelvis, for a distance of about 4 cm., behind the peritoneum, crossing the psoas major and the piriformis muscles and then the lumbosacral trunk of nerves. The artery ends in the pelvis minor by dividing, opposite the upper margin of the greater sciatic foramen, into two large trunks termed posterior and anterior divisions. The posterior division is the common stem of origin of the following parietal branches: iliolumbar, lateral sacral, and superior gluteal; the anterior division gives rise to both parietal and visceral branches, of which the inferior gluteal, obturator, and internal pudendal are parietal, and the superior vesical, middle vesical, middle hemorrhoidal, uterine and vaginal are visceral branches. All of the visceral branches and the internal pudendal artery call for further discussion.

Superior and Middle Vesical Arteries.—The superior vesical arteries (*arteriae vesicales superiores*) are slender vessels, one to three in number on each half of the pelvis. They arise from the anterior division of the hypogastric, the main stems dividing into numerous branches upon nearing the bladder, supplying mainly the superior and inferolateral surfaces. The lowest of the superior vesical arteries, distributed to the posterior surface of the viscus, is frequently termed the middle vesical. The superior vesical artery of the adult represents the proximal portion of the fetal umbilical artery (*a. umbilicalis*).

In the fetus the umbilical artery constitutes the main stem of the hypogastric, and is twice as large as the external iliac. It passes along the lateral pelvic wall, toward the apex of the bladder, whence it ascends to the umbilicus on the posterior surface of the anterior abdominal wall, on either side of the allantoic duct (urachus) enclosed between the peritoneum and the transversalis fascia. It is joined by the artery of the opposite side and by the umbilical vein, and passes through the umbilical cord to the placenta. When at birth the cord is tied and cut, the portion of each artery between the umbilicus and the bladder collapses, becoming converted into an impervious fibrous cord, the lateral umbilical ligament (*lig. umbilicale laterale*) or "obliterated hypogastric artery." The proximal portion, between the bladder

and the hypogastric artery, remains patent, and from it arise the one or more superior and middle vesical arteries.

The fibrous lateral umbilical ligament together with the middle umbilical ligament (page 215) and the inferior epigastric artery elevate the overlying peritoneum producing three folds on the anterior abdominal wall, one medial and two lateral. These peritoneal folds mark off three fossae of topographical importance on either side of the middle line above the level of the bladder and of the inguinal ligament: the supravesical fossa, between the middle and lateral umbilical folds; the medial inguinal fovea between the lateral umbilical and the epigastric folds; and the lateral inguinal fovea to the outer side of the epigastric fold.

Vaginal Artery.—The vaginal artery (*a. vaginalis*) represents the inferior vesical artery of the male. It passes downward and medialward from its hypogastric origin, to supply the vagina, and also sends small twigs to the lower aspect and the fundus of the bladder.

Uterine Artery.—The uterine artery (*a. uterina*) of each side originates from the anterior division of the hypogastric artery; it lies first on the inner wall of the lesser pelvis, passing medialward and slightly forward on the fascia covering the upper surface of the levator ani muscle, to the lower margin of the broad ligament; in the parametrial tissue, enclosed by the peritoneal layers of the ligament, it arches over the ureter about 2 cm. from the uterus. Upon reaching the cervix of the uterus, at a point just above the lateral fornix of the vagina, it gives off a vaginal branch, which courses downward on the lateral vaginal wall. The main vessel follows a very tortuous course upward (Fig. 96), along the lateral margin of the uterus between the layers of the broad ligament. The artery ascends as far as the fundus, giving off many spiral branches to the anterior and the posterior surfaces of the organ. These vessels anastomose not only with one another, but also freely with those of the opposite side. The uterine artery continues as a laterally directed stem, which divides into branches supplying the ovary and the uterine tube; the ovarian ramus (*ramus ovarii*) passes along the mesovarial border of the ovary, anastomosing with the ovarian artery; the tubar ramus (*ramus tubarius*) runs outward within the mesosalpinx, along the course of the uterine tube.

Middle Hemorrhoidal Artery.—This middle one (*a. hemorrhoidalis media*) of three hemorrhoidal arteries usually arises from the anterior division of the hypogastric (Fig. 89); it runs inward and then downward along the lateral surface of the middle portion of the rectum, supplying the viscus, and anastomosing with the superior hemorrhoidal artery from the inferior mesenteric, and with the inferior hemorrhoidal branch of the internal pudendal artery.

Internal Pudendal Artery (Pelvic Part).—The internal pudendal artery (*a. pudenda interna; internal pubic*) is one of the dorsal branches of the anterior division of the hypogastric artery. It arises on the side of the piriformis muscle, below the inferior margin of which it leaves the pelvis minor through the lower part of the greater ischiadic (sciatic) foramen; therefrom it winds over the ischial spine, covered by the gluteal muscles and enters the ischiorectal fossa through the lesser ischiadic foramen; to the latter, or perineal portion of the artery, we shall return, after having discussed the several vessels which, although not of hypogastric origin in the pelvis, yet assist in supplying pelvic viscera.

Sigmoid and Superior Hemorrhoidal Arteries.—These arteries are derived

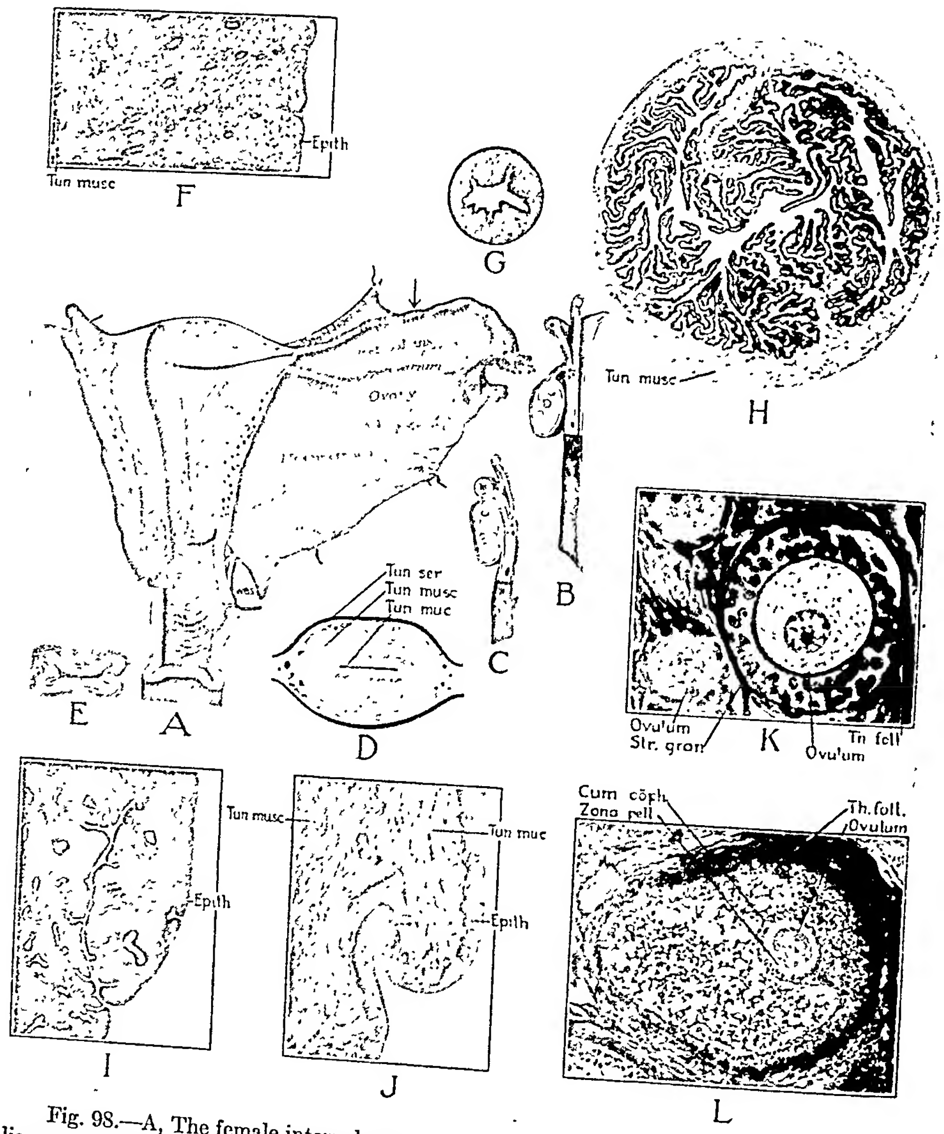

Fig. 98.—A, The female internal organs of generation, seen from behind. The broad ligament has been spread out on the right; on the left it has been cut and turned backward. The uterus and the vagina are partially opened. B, Schematic vertical section of the broad ligament at the level of the arrow in A; the mesometrium and the mesovarium have been spread apart. C, The same, with the portions of the ligament and the ovary in their normal relations. D, Transverse section of the body of the uterus (abbreviations below). E, Transverse section through the lower portion of the vagina; the lumen is compressed by the vaginal columns. F, Mucous membrane (*tunica mucosa*) of the body of the resting uterus, showing uterine glands (× 15). G, Transverse section through the uterine part of a uterine tube (× 15). H, Transverse section through the ampulla of a uterine tube showing the longitudinal folds of mucous membrane and the underlying layer of circular muscle (× 15). I, Mucous membrane of the cervix showing a cervical gland (× 15). J, Mucous membrane of the vagina; the section passes through one of the vaginal *rugae* (× 15). K, Section through a small primary follicle, and a larger follicle early in growth (monkey's ovary). The ovum contains a nucleus and a nucleolus

vein which is received not by the hypogastric vein but by the liver. All of the veins are associated with extensive venous plexuses (Figs. 88 and 89), which immediately surround the pelvic organs, and communicate with one another more or less freely.

The internal pudendal veins are associated through the greater part of their course with the artery of the same name; but they carry blood not only posteriorly through the perineum but also communicate anteriorly with the veins which lie within the pelvis immediately behind the pubic symphysis. The veins, which are usually double, in following the course of the pudendal artery on each side, begin with the deep veins of the clitoris which issue from the substance of the corpora cavernosa clitoridis; they receive, as they run dorsalward, the bulbar, perineal, and posterior labial veins in the urogenital triangle and the inferior hemorrhoidal veins in the anal triangle; in the latter region they are enclosed in the canal of Alcock with the artery and the pudendal nerve. The veins leave the perineum through the lesser ischiadic foramen and, after winding over the spine of the ischium, enter the pelvis through the greater notch; here they empty into the hypogastric vein.

The veins which course anteriorly receive as their chief tributary the dorsal vein of the clitoris, which is frequently double through part of its course. At the root of the clitoris the vein quits the dorsal surface of the organ, and, perforating the fascia of the urogenital diaphragm (compare Figs. 84 and 87), enters the pelvis through the small subpubic space enclosed by the pubic arcuate and transverse pelvic ligaments (page 210); here it sends a branch to either side of the pudendal plexus (*plexus pudendalis*). The latter network of veins is situated between the pelvic surface of the pubic symphysis and the urinary bladder. It drains into the hypogastric vein, but chiefly into the vesical plexus (*plexus vesicalis*) which is lodged in the cellular tissue surrounding the inferior aspect of the bladder, and is formed largely by veins received from that viscus. The vesical plexus communicates posteriorly with the uterovaginal plexus (*plexus uterovaginalis*). The veins which return blood to this plexus lie in the walls of the uterus and the vagina. In the uterus they form a distinct layer in the muscular wall, termed the *stratum vasculare;* passing outward and downward on both surfaces of the uterus to the lateral margins, they converge toward the uterine vein on each side, forming a plexus between the layers of the broad ligament. In the walls of the vagina the veins pass outward and upward, likewise joining the vaginal vein; thus the two portions of the plexus, uterine and vaginal, are continuous at the level of the external uterine orifice. The uterine veins, paired on each side of the pelvis, open into the corresponding hypogastric vein and also communicate posteriorly with the hemorrhoidal plexus (*plexus haemorrhoidalis*) which surrounds the rectum. The plexus consists of two intercommunicating portions, an internal situated between the mucosal and muscular coats, and an external upon the outer surface of the latter. The lower part of the plexus, as already mentioned, drains into the internal pudendal vein in the ischiorectal fossa; the middle part, through the middle hemorrhoidal veins, opens into the hypogastric vein; the upper part, by the superior hemorrhoidal and sigmoidal veins, reaches the inferior mesenteric vein. Through the medium of the plexus, and its connections with the hypogastric and the inferior mesenteric veins,

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uterus pass lateralward in the broad ligament, and, becoming continuous with those of the ovary, ascend with the ovarian vessels to the aortic glands; but some pass to the hypogastric and both groups of iliac glands. The efferent vessels of the uterine tube join those of the uterus and of the ovary. The vessels from the rectum pass upward to glands in the sigmoid mesocolon, and thence to the aortic glands; those from the anal canal end in the hypogastric glands; and, as has been stated, the lymphatics from the anus pass forward with those of the perineum to the inguinal glands.

Nerves.—The urinary bladder, the internal organs of generation, and the rectum are supplied by the pelvic part of the hypogastric plexus (*plexus hypogastricus*) of the sympathetic system of nerves. It receives peripheral branches (Figs. 89 and 93) from the four ganglia (*ganglia sacralia*) on the pelvic portion of each sympathetic trunk; and gray communicating rami from the second to the fourth sacral (spinal) nerves. The nerves form a network which is continuous behind with the hypogastric plexus, and from which fibers extend forward along the course of each hypogastric artery to be distributed to the pelvic organs supplied by the artery's visceral branches. The entire plexus is thus subdivided into the secondary plexuses. The most posterior of these is the middle hemorrhoidal plexus (*plexus haemorrhoidalis medius*) which is distributed to the rectum. The uterovaginalis plexus (*plexus uterovaginalis*) is placed in an intermediate position within the pelvis minor; it follows the course of the uterine artery, and then ascends between the layers of the broad ligament to spread out upon both surfaces of the uterus. The plexus is of large size corresponding to the high development of the muscular layer of the uterus which receives most of its fibers. Fibers are also sent to the walls of the vagina, and to the erectile tissue of the bulb. The vesical plexus (*plexus vesicalis*) is associated with the urinary bladder. The fibers of this plexus accompany the vesical arteries to the bladder, and are distributed chiefly to its muscular layers. The sympathetic fibers which supply the ovary are derived not from the sacral ganglia, but are contributed by the renal and aortic plexuses; they accompany the ovarian artery in its descent into the pelvis, and enter the ovarian substance through the hilum.

The musculature which forms the walls and the floor of the pelvis minor receives its innervation from the ventral divisions of the last lumbar and the sacral nerves. The piriformis muscle receives twigs from the first and second sacral nerves, which enter the pelvic surface. The coccygeus and levator ani muscles are supplied by branches of the third and fourth sacral nerves upon their pelvic surface; the latter muscle also receives, upon its perineal aspect, fibers from the perineal branch of the pudendal nerve. Fibers from the fifth lumbar and first and second sacral nerves accompany the pudendal nerve, through the ischiadic foramina, from the pelvis to the perineum and there innervate the obturator internus muscle.

The pudendal nerve itself is the chief source of muscular and cutaneous innervation in the perineum. The nerve of each side represents the smaller portion or band of the pudendal plexus (*plexus pudendus;* sacral plexus) the larger component being the sciatic band, which, continuing as the nerve of the same name, supplies the lower extremity. The pudendal nerve (*nervus pudendus*) is derived from the anterior rami of the second, third, and fourth sacral nerves; it accompanies the internal pudendal artery and vein, leaving the pelvis through the greater ischiadic foramen, and entering the ischiorectal

send cutaneous fibers through the sacrotuberous ligament which, in the main, turn around the inferior border of the gluteus maximus muscle to supply the skin of the buttocks; some of the fibers, however, turn forward into the perineum. The perineal branch of the fourth sacral nerve enters the ischiorectal fossa by passing through the coccygeus muscle of the pelvic diaphragm; it supplies the skin of the perineum between the anus and the coccyx. The anococcygeal nerves (*nn. anococcygei*) are derived from the fourth and fifth sacral and the coccygeal nerve, which unite along the coccyx to form a plexiform cord; small branches pierce the sacrotuberous ligament, and supply the skin behind the anus in the coccygeal area.

Muscles and Fasciae of Pelvis

The muscles which cover the walls and constitute the floor of the pelvis minor belong to two groups: Those of the lower extremity, the obturator internus and the piriformis; and those which form the pelvic diaphragm, namely, the coccygeus and the levator ani. The fasciae of the above muscles are continuous with one another, and likewise with the transversalis fascia of the abdomen and the aponeurotic layers of the perineal compartments; they also provide fibrous coverings for the pelvic organs.

The piriformis muscle (*m. piriformis*) is triangular in outline, and lies flattened against the posterior wall of the pelvis minor (Figs. 90 and 92). It originates by three (or more) processes, lateral to the second, third, and fourth anterior sacral foramina, and becoming narrower and more rotund, leaves the pelvis through the upper part of the greater ischiadic foramen, for insertion into the greater trochanter of the femur. The thin fascial covering of the muscle is prolonged upon it from a sacral attachment into the gluteal region. The piriformis, together with the coccygeus muscle, closes the space in the posterior bony wall of the pelvis (page 197) intervening between the ischium and sacrum (Fig. 91).

The obturator internus muscle (*m. obturator internus*) clothes the side-wall of the pelvis minor and like the piriformis is flattened and fan-shaped (Fig. 90; compare Fig. 91). It arises from the circumference of the obturator foramen from which its fibers converge toward the lesser ischiadic foramen; becoming tendinous, it is joined by the two gemelli, and with them, is inserted into the greater trochanter of the femur.

The fascia covering the pelvic surface of the muscle (*fascia obturatoria*) is attached above to the periosteum along the arcuate line, where it is continuous with the iliac fascia covering the iliacus muscle in the pelvis major; in front it is attached to the superior ramus of the pubis, and below to the pubic arch, where it forms the fascial canal (of Alcock) housing the pudendal vessels and nerves. Midway in its course the layer gives origin to the two layers of the diaphragmatic pelvic fascia (pages 213 and 215); it is carried outward with the muscle to blend with the tendon of insertion.

The coccygeus muscle (*m. coccygeus*) and the levator ani (*m. levator ani*) form, with their fellows of the opposite half of the pelvis minor, the muscular constituents of the pelvic diaphragm (Figs. 90 and 92). Each coccygeus muscle is thin and quadrangular, and is situated on the anterior surface of the sacrospinous ligament. It takes origin from the spine of the ischium and, expanding, inserts into the lateral margin of the lowermost segment of the sacrum and of the upper part of the coccyx. Its thin fascial investment is

CHAPTER II

THE BONY AND LIGAMENTOUS PELVIS

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BIOLOGY OF THE PELVIS

The bones and ligaments which form the pelvis of the human female, especially those which enter into the formation of the true pelvis, are the most important factors in shaping the parturient canal and in determining the mechanics of labor. The pelvis, when considered in relation to the forces of labor, is mentioned as the dynamic pelvis. This might be called the obstetrical pelvis.

The biological and anatomical conception of the bony pelvis would be that of a girdle or ring, which serves to attach the hinder or lower limbs to the trunk or body of its owner. Physiologically, aside from its obstetrical importance in the female, it would be thought of (1) as a protecting cage for the contained structures and organs, (2) as a means of transit for various vital structures passing from the trunk to the lower extremities and to the external environment, and (3) as a firm but mobile site for the attachment of the superimposed skeleton and the fibromuscular structures, which make possible coordinated movements between the lower extremities and the trunk. In humans and animals habitually assuming the erect posture, there is the necessity of having the anatomical relations so arranged as to afford opportunity for the adequate support of the pelvic and abdominal viscera.

It is easy to see that, phylogenetically, there are variations in the functions that have been mentioned which are reflected in anatomical variations in different species. There are also definite ontogenetic diversifications which occur on the basis of age and development, sex and race. In a chapter for physicians, it is not necessary to go into some of these changes in great detail, but some points, illustrative of anatomical alterations in relation to function, may be of value and interest.

Some sort of pelvic girdle is present in most of the vertebrates. There is a great deal of variation in form, depending on the absence or presence of hinder or lower extremities, the species in which they are present, and the use to which they are put. In fish there is only a rudimentary form of pelvis, and though there are many variations the ilium is almost always absent. Some snakes, as the boa and python, have a rudimentary pelvis. Crocodiles and turtles have a pelvic arrangement similar to that of man. Amphibians, in contrast to fish, have a well-developed ilium and almost all have an ischium. In frogs the ilium is a well-developed, long bone which makes up about one-third of the body length. It is firmly attached to the ischium and pubes. The well-developed ilium is a response to the physiologic necessity for an extensive attachment for the powerful muscles of the lower extremities. In birds the pelvic halves are not united at the pubic symphysis, except in

seen in the bear, kangaroo, ape, and man. In beasts of burden and of prey, but especially in the former, the pubic symphysis is better developed and stronger than the sacro-iliac synchondrosis. This is seen in the horse, cow, hippopotamus, elephant, leopard, etc. In certain domestic animals as the horse, cow, sheep, and swine, the sacro-iliac junction is quite movable. In mares the ilium is attached to only one vertebra and the broad pelvic fascia is about the only important structure which closes the pelvis. The mobility of lumbosacral and iliosacral articulations is much greater in cows than in mares; in sheep and goats the sacral vertebrae are movable and in swine there is marked concavity of the sacrum with extreme mobility of the lumbosacral and iliosacral joints. In dogs the sacro-iliac joint is so movable as to form a diarthrosis.

The relation of the trunk and especially of the vertebral column to the pelvis varies a great deal in different species. It is easily seen that the spine follows a much straighter line, from neck to sacrum, in quadrupeds than in man, where there are the compensatory curves of the vertebral column. In most of the mammalia there is no sacral promontory, but in some it is more or less marked, although in none is it so prominent as in man. The angle made by the anterior surface of the fifth lumbar vertebra with the anterior surface of the first sacral is less in all mammalia than in man. The angle formed between the frontal planes of the anterior surface of the lumbar vertebrae and of the pelvic inlet is greater in all other mammals than in man. These angles and the type of pelvis in the anthropoid ape approaches more nearly to that of man than do those of any other of the vertebrates. The component sacral vertebrae seem to be relatively fewer in these animals than in man.

There are many other pelvic variations between the lower animals and man, which are manifested by differences in size, form and relation to other skeletal parts. In general, there is a broadening of the iliac bones in man as compared with other mammalia which have a narrower pelvis. According to Albrecht, "man alone possesses a fossa iliaca interna." The superficies iliaca interna is concave in man alone, who has a convex externa. In the pelvis of apes, which approaches the human most closely, the interna is more or less convex. Man alone has an anterosuperior spine projecting above the incisura interspinalis anterior and he also has the shortest space between the anterosuperior and inferior spines. It is also of interest to note that the dorsal surface of pubic symphysis is convex in man and concave in apes. There has been some difference of opinion as to whether or not there are sex differences in pelves of mammalia. Some have thought (Wiedersheim) that sex differences in pelves were a human characteristic. In higher mammalia there seems to be definite sex differences. Franz found in ewes that the bones of the pelvis were more delicate, the canal more roomy and larger, especially in the transverse diameter, than in rams. Females have flatter ilia and wider pubic angles, from about 90 to 100 degrees as compared with 60 degrees for the males. These differences tend to disappear in castrated animals, producing an asexual type of pelvis. Disselhorst is of the opinion that there are sexual differences in the pelves of all quadrupeds and quadrumana. The chief sexual differences are that female pelves are more roomy and have more delicately formed bones. The ventral portion has a more marked forward slope and a greater excavation. The pubic spine is not so

methods. In connection with the development of the bony pelvis, it should be remembered that there are two main types of bone, viz., those which develop from membrane and those which pass through the chondrogenic phases. A discussion of the development of the bony pelvis does not involve the former type. All other types of bone pass through three stages in their process of development: (1) The blastemal, or mesenchymal, (2) the chondrogenic, or cartilaginous, and (3) the ossification, or bony phase. The first center of ossification to appear in the human embryo is in the clavicle about the sixth week of fetal life, where it develops in mesenchymal tissue even before the chondrogenic stage. Ossification centers appear soon after this in the cartilaginous pelvis (Fig. 99).

The development of the bony pelvis may well be considered with relation to the different stages of life: first, the fetus; second, the infant; third, the child up to puberty; fourth, the adolescent to maturity. It is well known that the bony pelvis is made up of the sacral and coccygeal elements—the ilium, ischium and pubis. The sacrum usually consists of five vertebrae, but there may be lumbarization, partial or complete, of the first sacral. In other instances there may be sacralization of the fifth and even of the fourth lumbar vertebra. All of the sacral vertebrae, except the first, are rudimentary. The coccyx usually has four rudimentary vertebrae, rarely five, but never more. The human embryo of from 4 to 6 cm. exhibits a rudimentary coccygeal tail, the tip of which is called the *vertex coccygeus* where it touches the skin: this is replaced by the glabella coccygeus or at times there may be a small depression termed the *foveola coccygea.*

The bony pelvis of man must be considered to arise from two sources: first, the lower portion of the vertebral column, which is made up of component vertebral elements, the development of which is analogous to that of other vertebral segments: second, the upper portion of the lower extremity or the pelvic girdle. The chorda dorsalis develops in early embryonic life, apparently from the primitive streak. It appears in close association with the disappearing neurenteric canal in the anterior portion of the embryo. The chorda with its encircling membrane reaches the acme of its development about the fourth fetal week. Some condensations of the axial mesenchyme appear during this time and mark off the vertebral column. The notochord is surrounded by the vertebral bodies and intervertebral disks, and disappears about the time ossification commences, though persisting in the intervertebral disks as the nucleus pulposus. The segments of axial mesenchyme are called *scleromeres*, and from these the blastemal or primitive vertebrae are formed. Three centers of chondrification appear on either side of these primitive vertebrae: (1) For the body, (2) for the neural arch, and (3) for the costal process. The two centers for the body soon fuse. This represents the typical development of a vertebra. The development of the segments of the sacrum and coccyx is atypical and shows considerable variation from the usual or normal type.

The variation is mostly in the costal and neural processes. The latter produce the radicular, articular, transverse and laminary processes. The former fuse with the transverse processes of the neural cartilages. The later union of the costal processes forms the sacral surface, which articulates with the ilium. All the sacral centers fuse to form a single cartilaginous sacrum. Only the first two coccygeal vertebrae have incompletely developed

mentioned. The pelvis is peculiar in that it is made up of the caudal portion of the axial skeleton and the upper part of the lower appendicular skeleton.

The ossification centers in the vertebrae are primary and secondary; the former appear in fetal life and the latter are evident about the eighteenth year. During fetal life the ossification centers of the bodies of the five sacral vertebrae appear. According to Bardeen, each body and each hemiarch has a primary center, prior to birth. The costal centers show greater varia-

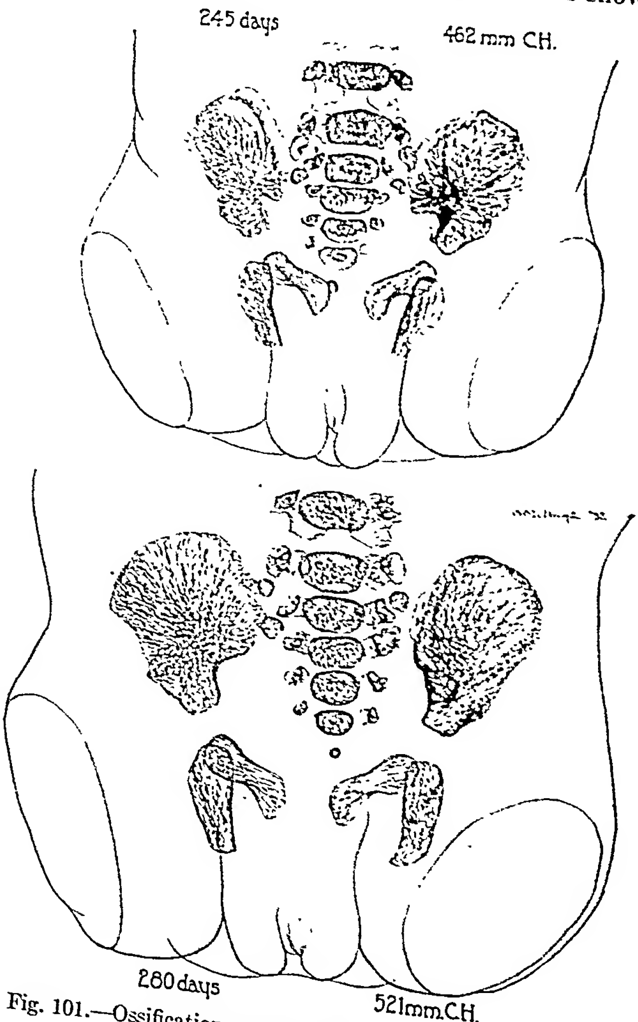


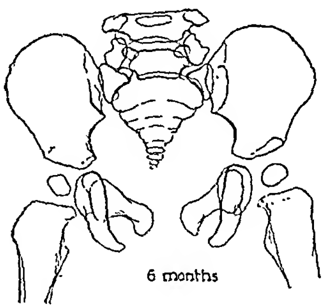
Fig. 101.—Ossification centers of the pelvis in newly born.

bility and two or more may be present at birth. Adair found in his series of pelves that the centers appeared in the bodies during the fourth month, while those of the neural arches were first seen during the fifth and sixth months. The costal elements exhibit their centers in the fifth, sixth and seventh months in the first, second and third vertebrae (Fig. 100). As a rule, all other sacral centers appear after birth.

The median center of the first sacral is the first one to appear after the

which are gradually increasing in size; new centers are being laid down and the remaining costal elements appear (Fig. 103).

The cartilaginous coccyx develops additional centers so that ossification of the bodies is complete in the first within five years (Figs. 104, 105) in the second in from five to ten years (Fig. 106), in the third during the period from ten to fifteen years (Fig. 107), and in the fourth between the fifteenth and twentieth years (Fig. 108). The fusion of the sacral vertebrae begins about puberty at the base and extends upward to completion about the twenty-fifth year (Fig. 109), though



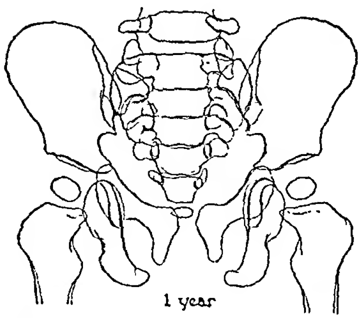


Fig. 103.—Ossification centers of the pelvis in infancy.

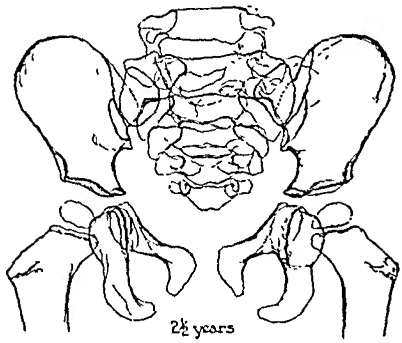


Fig. 104.—Ossification centers of the bony pelvis in childhood.

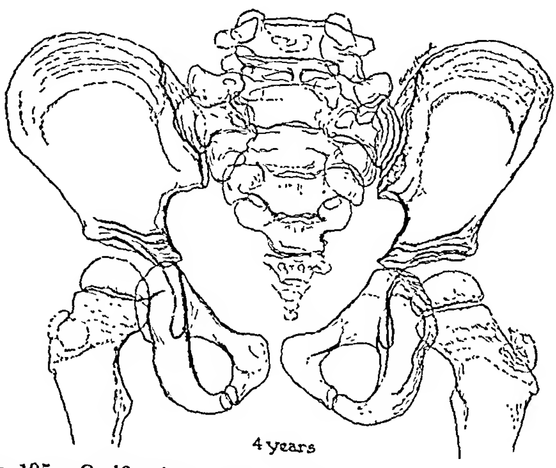


Fig. 105.—Ossification centers of the bony pelvis in childhood.

the epiphyses which appear in the fifteenth year are not united until the thirtieth year.

The sacral epiphyses consist of three groups: those between the bodies of the sacral vertebrae, those on the protuberances, which fuse to form a

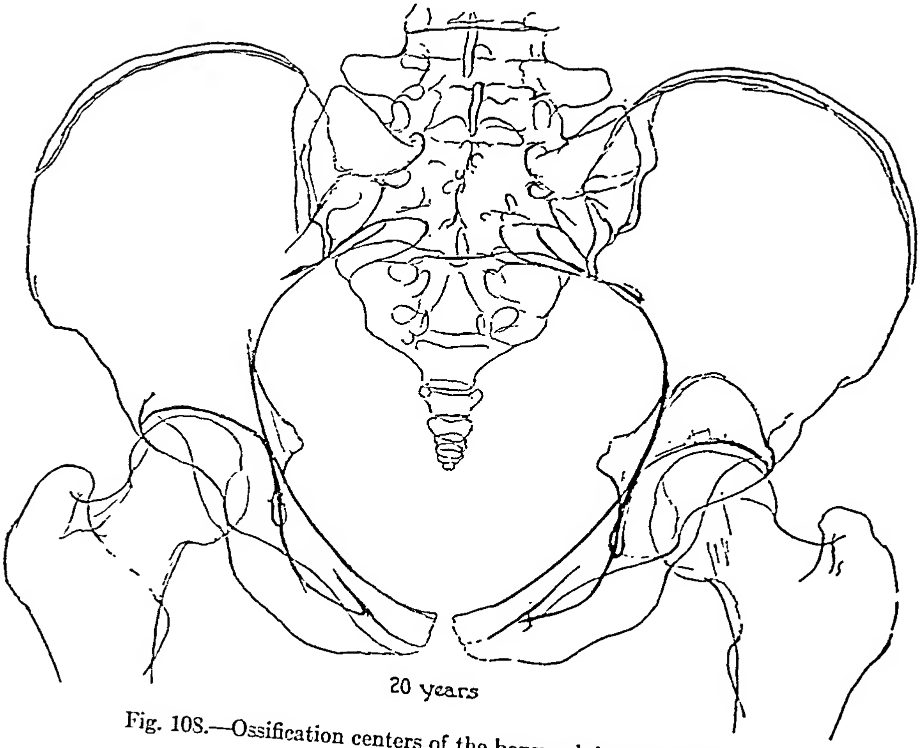


Fig. 108.—Ossification centers of the bony pelvis in the adult.

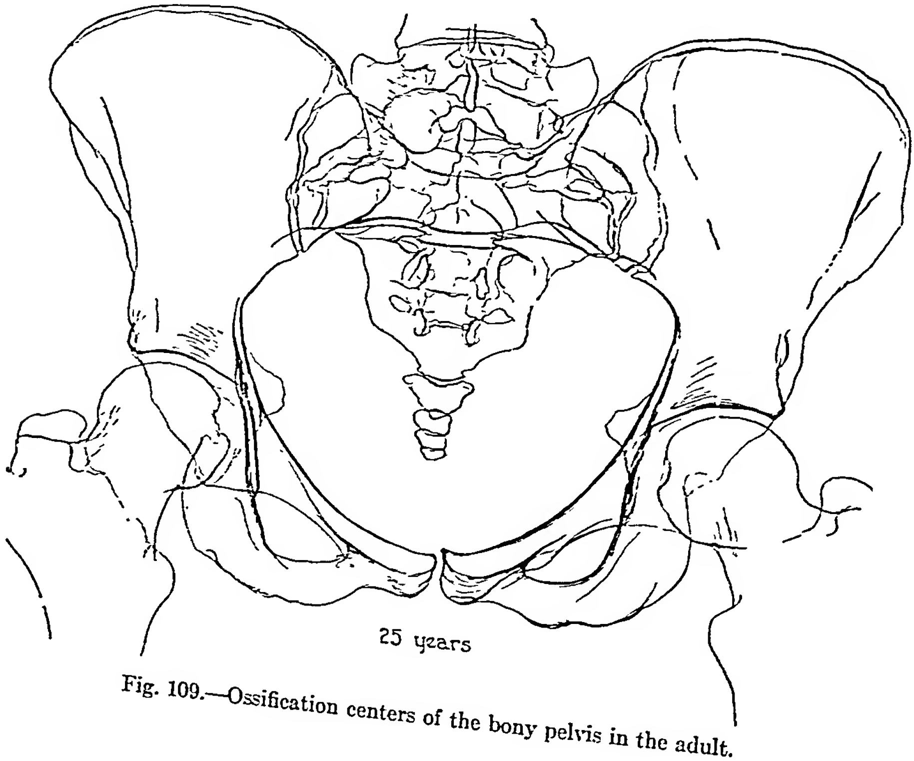


Fig. 109.—Ossification centers of the bony pelvis in the adult.

doubted, as has been demonstrated by their study in abnormal pelves. though it has been impossible to correctly evaluate the effect of individual factors. The resultant of some of these forces is seen in individuals afflicted with diseases, such as rachitis and osteomalacia, which have produced long-continued softening of the bones. The mechanical factors are only a part of the influences which operate upon the pelvis. They are practically the same in all races, sexes and individuals and yet there are definite variations due to heredity and probably to endocrine control, which not only determines growth but also the type. The effect of endocrine action is noticed in the asexual type of pelvis seen in early castrates. Growth in conjunction with mechanical factors is of importance. In cases in which growth and ossification proceed normally and the timing of the mechanical factors is correct, a normal pelvis should result, barring hereditary or congenital defects. The unequal rate of growth of the different parts of the bony pelvis surrounding

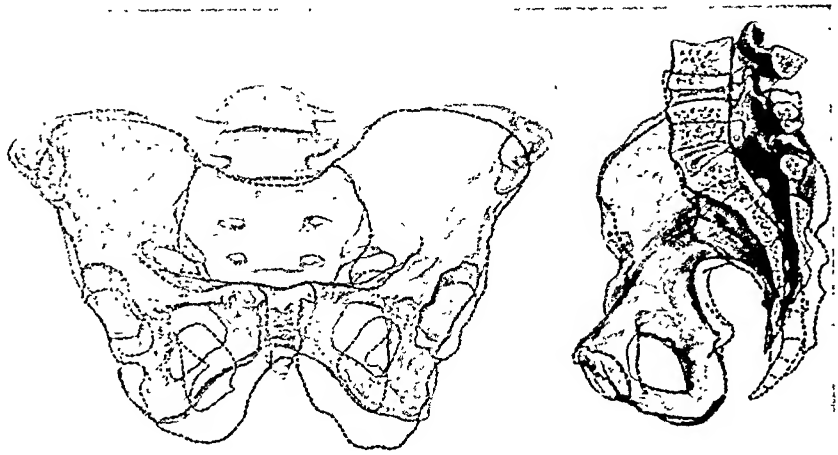


Fig. 110.—Views of female pelvis with male pelvis superimposed in dotted outline.

the brim has been thought by Breus and Kolisko to be an important factor in changing the pelvis from the fetal to the adult type.

Growth does not seem to be a steady process but is subject to certain periods of acceleration. In girls, at least in skeletal growth, there are spurts of growth between six and eight, and ten and thirteen years of age, which carry them forward about eighteen months ahead of the boys. The pelvis participates in this general conduct, but not uniformly, as the different elements do not grow at the same pace. The sacrum becomes steadily wider until the eighth year when its growth is arrested until the next spurt just before puberty. The ilium grows steadily and it is quite fully developed at puberty. The pubes grow more slowly. The inlet is nearly round at birth and it resumes this circular or perhaps oval form between the eighth and twelfth years. After puberty there is an acceleration of pubic growth in length, and of sacral length, so that the inlet and the pelvis rapidly assume the normal adult form.

Sex differences in the pelves of male and female are marked (Figs. 110, 111), and demonstrate conclusively that other than mechanical factors

There is a striking difference in the pubic arches of the female and male pelves, the angulation of the former being from about 90 to 100 degrees and that of the latter, approximately, from 70 to 75 degrees. Not all females, even of the same race, have the same type of pelvis and some approximate the male type. The various sexual types are due to hereditary and developmental influences, possibly of a hormonal nature which produce other sexual variations.

Race variations have been described by various authors and are natural phenomena, which one could expect just as much as racial variations in body size and form and in the integument. Racial skull types have long been recognized. The more marked the racial distinction, the greater the differentiation in the type of pelvis. Stein has mentioned four racial types: (1) The cordiform or broad heart shaped; (2) the transversely oval; (3) the circular and (4) the longitudinally oval. Various other methods of classification have been attempted.

Topinard employed the height-width index, using the intercrestal diameter as the criterion of width. He demonstrated by his measurements that the pelvis became broader and lower as the races were higher in civilization. Krukenberg states that there is less marked lumbar lordosis in the lower races than in the higher, but that in all this lordosis is more noticeable in the female than in the male. The sacrum is more concave in the higher races. The lower tend to retain more the form seen in primates and in the newly born infant. The sagittal and transverse diameters are more nearly equal. He accepts Turner's classification of pelves into: (1) The dolichopellic; (2) the mesatipellic; (3) the platypellic. Turner and others have found these different types among races of men. The dolichopellic form has been found among the women of the aborigines of Australia, the Bushmen of Africa, the Hottentots, the Kaffirs and the Andamans. The mesatipellic form occurs among the negroes and many Malays. The platypellic pelves occur among the Caucasians and the Mongols. In all of these types there are differences between male and female pelves, which sex differences have also been demonstrated in lower animals. The superior races show that the sacrum sinks deeper into the pelvis than in the inferior types (Bolk). Hasebe found in 10 per cent of the Japanese women evidence that the fifth lumbar vertebra was separated into an anterior and a posterior segment. This is seen seldom among members of the Caucasian races and produces the spondylolisthetic pelvis. Less marked variations have been noticed among various white nationalities. These variations are both in size and to some extent in type. The English and Holstein women are thought to have broader pelves. Gache believes the Mexicans often have funnel-shaped pelves. Adair found the average pelves of French and American women to be of different size.

The individual variations of pelves within the range of the usual or normal are quite marked even in the same nationality, but these differences are particularly important and striking in the United States of America where so many different nationalities are represented and there is so much racial and national intermingling. In a chapter dealing with the bony and ligamentous pelvis from an obstetrical and gynecological viewpoint, it is not necessary to enter into detailed anatomical descriptions of the structures. The preceding comments have been incorporated to give some idea of the relationship of

that it was a firm, bony girdle. Columbus (1494–1559) and Arantius (1530–1589) also contributed to our knowledge of the pelvis and the latter was the first to describe the contracted pelvis.

Contrary to the teaching of the above anatomists, Paré (1510–1590) continued the belief in the separation of the pelvic bones during the process of labor. There has been much difference of opinion relative to ligamentous changes during pregnancy and labor. The anatomists and many obstetricians contend that there is no elasticity to the bony parturient canal and that the articulations are rigid supports. Many clinical observations and some experimental work, especially with hormonal action, tend to lead one to the conclusion that there are certain changes in the sacro-iliac joints and in the pubic symphysis which make the pelvis a more elastic girdle than it is commonly supposed to be.

Deventer (1651–1724) was the first obstetrician to make a study of the pelvis and he made noteworthy contributions. He recognized sex and individual pelvic variations and had some idea of sacral mobility. His important contribution was his understanding of the importance of the shape and direction of the pelvic cavity in the mechanism of labor. He named no pelvic diameters and did not designate the pelvic axis.

Levret (1703–1780) studied the pelvic planes and the axis and was the first to use the pelvic curve in the forceps and also to employ the designation of inlet (Entrée) and outlet (Sortie) for the pelvis. Huwé was the first to measure the true pelvis and the fetal head as well as to mention the inclination of the pelvis. John Burton (1697–1771) was the first obstetrician to measure the interspinous and intercristal diameters. About the same time, Camper (1722–1789), deWind (1714–1771) and Smellie (1697–1763) contributed further knowledge concerning the pelvic cavity. They initiated the idea of the relationship of the various pelvic diameters to the diameters of the fetal head.

Ould (1710–1789), who founded the present ideas of the mechanism of labor, described the method of the entrance of the head into the pelvic inlet. He considered the shape and form of the head with relation to the inlet without giving the actual measurements. The classical contributions of Smellie established the more exact relationship of the cephalic to the pelvic measurements in the different zones of the parturient canal. Smellie was the first to give the measurements and relationships of the different parts of the pelvis in depth; he considered the ratio of the anterior to the lateral and to the posterior pelvic walls to be as 1:2:3. He also advocated the idea that the bones of the pelvis were not separated to any noticeable degree during labor, but that there was a certain elasticity to the articulations.

Levret was in error concerning the relationship of the pelvic diameters, but he recognized the level of the ischial spines to be the narrowest portion of the pelvis. Ritgen (1787–1867), some seventy years later, applied the term "Beckenenge" to this plane and also mentioned the "Beckenweite." Roederer (1726–1763) stressed the inclined plane, made by the bend of the sacrum and the coccyx; he was the first one to use the term "conjugata" for the diameter of the inlet running from the pubic symphysis to the sacral promontory. The elder Stein (1773–1870) contributed much to the knowledge of the pelvic and the parturient canal.

Hodge (1796–1873) conceived of parallel planes, which were projected

line as it varies in the amount of flexion anterior and lateral as it passes through the pelvis. The head must pass down in the parallel planes, as conceived by Hodge, in almost a straight line until its large diameter is below the level of the symphysis when it follows a curved line of direction. Such a line straight in the upper and rather sharply curved in the lower portion of the parturient canal should be regarded as the obstetrical axis of the pelvis.

ANATOMY OF THE PELVIS

An anatomical description of the pelvis can be rather brief as our major interest lies in the bony pelvis and its obstetrical significance. The anatomical pelvis is a girdle which is made up of four bones after fusion of the various component segments has occurred, as it usually has by the twenty-fifth year. The coccyx usually remains as an independent bone. The os coccygeus is made up principally of the bodies of four or five rudimentary vertebrae. The first one has two cornual processes and two transverse processes. A superior flat surface is united to the lower surface of the sacrum by the symphysis sacrococcygea. Usually the upper three vertebrae are attached to each other by fibrous bands, while the third, fourth and fifth have an osseous union. Occasionally the upper ones have a bony union which may extend to the sacrococcygeal symphysis. It is easy to see that injuries may occur to the coccyx during parturition, especially if abnormal bony union interferes with the elasticity. The ligamentous attachments are rather slender and consist of bilateral, together with superficial and deep anterior and posterior, ligaments. These bands are rather fragile and may be easily stretched or torn by birth trauma.

The sacrum shows certain sex differences, being wider, shorter and less concave on its anterior surface in the female. Its five component vertebrae are fused. They are progressively more rudimentary from above downward. The upper surface of the first sacral is firmly united with the last lumbar vertebra through the intervention of the intervertebral disk with its contained nucleus pulposus. The supporting ligaments consist of the anterior and posterior longitudinal ligaments, the ligamentum flavum, the interspinous and supraspinous ligaments. The ligaments are subject to injury and lumbosacral strain may result from parturition.

The partes laterales, with their sacral tuberosities, form a site for the attachment of the interosseous sacro-iliac ligaments. They are derived mostly from all the transverse processes and also from the costal processes of the first, second and third sacral vertebrae. The articular surfaces are formed mostly by the first sacral vertebra and unite with the articular surfaces of the iliac portion of the innominate bones.

The articulatio sacro-iliaca is of very great obstetrical significance and the cartilaginous surfaces are held together by an anterior sacro-iliac ligament, which makes up part of the posterior and lateral facies of the birth canal. This attachment is further strengthened anteriorly by the iliolumbar ligament which sends the major portion of its strong fibrous bundles from the transverse processes of the fourth and fifth lumbar vertebrae anteriorly to the ilium and sacrum, though it also is furnished attachment to the posterior portion of the iliac crest, both anteriorly and posteriorly. The strong interosseous ligaments give support posteriorly and they are assisted by the long and short posterior sacro-iliac ligaments which cover them. These joints are

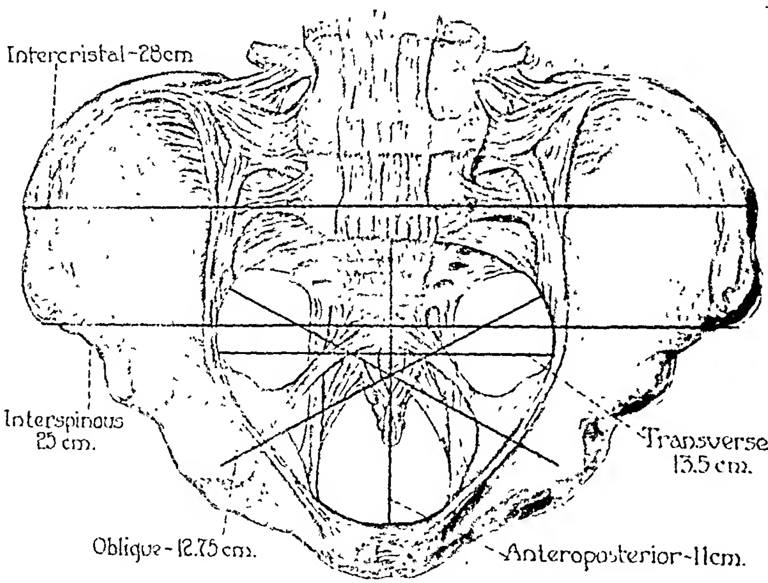


Fig. 112.—Bony and ligamentous pelvis showing various measurements.

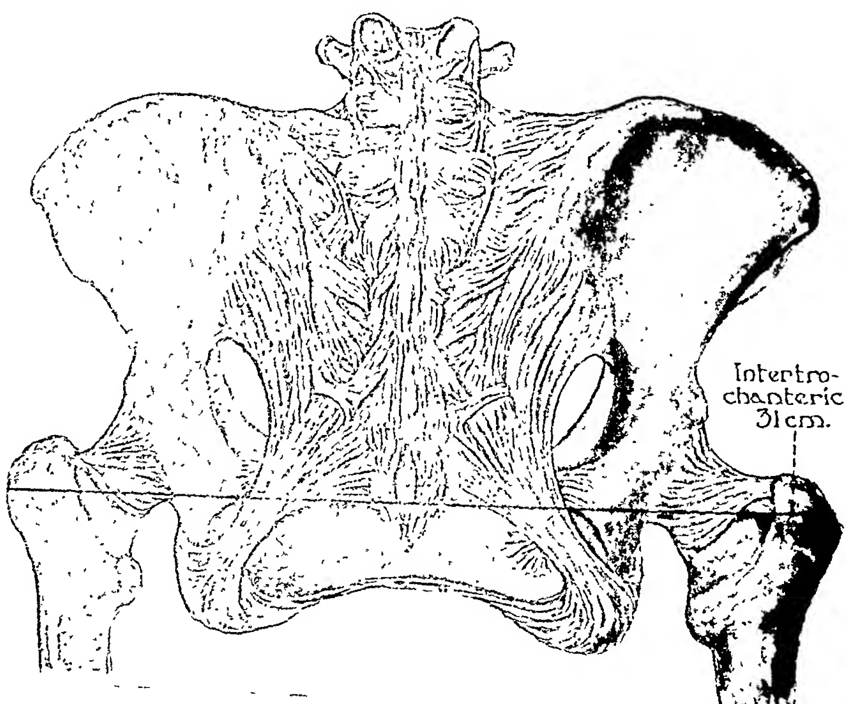


Fig. 113.—Posterior view of bony and ligamentous pelvis.

the right posterosuperior iliac spine and the left anterosuperior iliac spine, $22\frac{1}{2} \pm$ cm.; the left external oblique, $22 \pm$ cm.; the intertrochanteric, or the maximum width between the greater trochanters, $31 \pm$ cm. These

Smellie first called attention to the importance of the diagonal conjugate. This diameter can be quite accurately determined by digital examination and measurement. Meyer described the normal conjugate which makes an angle of 30 degrees with the horizontal. This diameter runs from the upper inner margin of the pubic symphysis to the middle of the body of the third sacral vertebra. Other diameters than the conjugates are closely related to the superior strait. The transverse diameter of the inlet represents the greatest width in this plane. It runs between the points, on the linea terminalis of either side, which are most widely separated. The line runs at right angles to the anteroposterior diameters and measures 13.5 ≐ cm. normally.

In addition, there are two internal oblique diameters, the length of which is 12.75 ≐ cm. They run in the plane of the inlet from the sacro-iliac junction of one side to the iliopectineal eminence of the opposite side. They are termed right and left, or first and second, the former originating from the right sacro-iliac joint and the latter from the left.

In addition to the plane of the superior strait, there are other planes which have been mentioned in the historical consideration of the pelvis. As the result of the development of our knowledge of the pelvis, one can now recognize certain planes of the pelvis as important for a proper understanding of the mechanism of normal and abnormal labor. The next plane to be considered is that of the greatest dimensions, which was first recognized by Levret. This plane passes through the junction of the second and third sacral vertebrae, the midpoint over the acetabulum and the middle of the pubic symphysis, all on the facies pelvina. This plane is nearly circular, measuring 12.75 ≐ cm. in the transverse, and 12.5 ≐ cm. in the anteroposterior diameters. The circular character of this plane favors rotation of the presenting part of the fetus.

The oblique diameters terminate in the membranous and fascial tissues over the sacrosciatic notches and the obturator foramina. (This plane is nearly identical with the second parallel of Hodge and the main plane of Veit.) From this plane the descending fetal head usually enters with its long diameter in the anteroposterior diameter of the plane of least pelvic dimensions. This plane is bounded laterally by the ischial spines, the distance between which is 10.5 ≐ cm. and constitutes its transverse diameter. The anterior and posterior points in this plane are the tip of the sacrum and the lower margin of the symphysis pubis; the distance between these points measures 11.5 ≐ cm. The transverse diameter of this plane is the shortest in the obstetrical bony pelvis.

The inferior strait passes through the tip of the coccyx, the sacrotuberous ligament, the tuber ischii and the pubic arch anteriorly. The transverse diameter is the distance between the inner surfaces of the ischial tuberosities and measures 11 ≐ cm. The length of the transverse diameter is more or less of an index of the angle of the pubic arch which in the women is about 90 to 100 degrees (Fig. 115).

The anteroposterior diameter runs from the apex of the pubic arch to the tip of the movable coccyx which permits of an expansion from 9.5 ≐ cm. to 11.5 or 12 cm. when the coccyx is displaced backward. This gives the anatomical conception of the outlet, but the obstetrical outlet has a rather different aspect, especially when viewed in profile. It consists of two inclined

posterior diameters, depending upon the amount of flexion, to the inlet diameters which are long enough to accommodate them. It is to be noted that the shortest diameters of the head in the sagittal plane and the smallest circumferences appear when the head is either in marked flexion or extreme extension. Of these diameters, the longest is the occipitomental; it is 13.5 ± cm. long and can enter the superior strait in the transverse diameter only under favorable conditions. It would be unable to pass through any of the diameters of the successive pelvic planes. The occipitofrontal is the next longest, 11.75 ± cm., and it would encounter serious obstruction in any diameters below the pelvic brim. The most favorable measurements are the suboccipitobregmatic, 9.5 ± cm., and the short frontomental. The biparietal (9.25 ± cm.) and the bitemporal (8 ± cm.) diameters are in transverse planes and may pass through nearly any pelvic diameters.

THE PELVIC SOFT PARTS

The relations of the soft parts to the bony and ligamentous pelvis are of great importance for an understanding of regional and applied anatomy. The interposition of these soft parts reduces the internal diameters and the space available for the fetus in its passage through the parturient canal. The musculofascial layers which line and cover the pelvis are very important in the relations of the pelvis to the trunk and the lower extremities. The obstetrically important structures of this type are mostly within the true pelvis and provide for the proper support of the pelvic and abdominal viscera. They also must furnish mechanisms for the proper carrying-out of the functions which take place through the pelvic outlet. These functions have to do with urination, defecation, coitus and child-bearing.

The concave fossae iliacae are smoothed out by the musculus psoas and the musculus iliacus, both of which lie above the superior strait. The lateral walls of the pelvis are covered with muscles and fascia. The most deeply attached muscle in the true pelvis is the musculus obturator internus which covers the obturator foramen and membrane, except for the canalis obturatorius. It passes out of the pelvis through the foramen ischiadicus minus. This muscle is largely covered by the levator ani and its fascial attachment, the arcus tendineus.

The musculus piriformis is attached posteriorly, and passes out through the foramen ischiadicus majus leaving openings above and below which are termed the foramen suprapiriforme and the foramen infrapiriforme. The lacuna musculorum and the lacuna vasorum are important musculofascial fossae, but of more surgical than obstetrical importance. The former is the site of psoas abscesses and the latter is often identified as the site of femoral hernia.

The urogenital cleft is the most important orifice to consider for the obstetrician and the gynecologist. This is the opening which is especially apparent after childbirth as the canal between the lateral halves of the musculus levator ani and accessory muscles of the pelvic floor. Similarly, the urethra and rectum pass through the musculofascial planes of the pelvis. Occasionally a defective opening may appear between the musculus levator ani and the coccygeus, and here a perineal hernia may develop.

The urogenital cleft and the birth canal are of the utmost importance and the obstetrical anatomy of the soft parts, described by Anson, see Chap-

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Wind, de: 'T geklend hoofd geredt, Middelburg, 1752.

Wiedersheim: Zur Urgeschichte des Beckens. Ber. d. naturf. Gesellsch. zu Freib. i. Br., 1888.

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even today, arguing that in man's progenitor, perhaps even before he came down from the trees, there was in all probability a sex season like that still seen in the lower animals, that its rhythm was determined by the lunar cycle, which must have been one of the most important influencing factors in the activity of such primitive beings, and that this rhythm still persists in spite of the fact that an easier environment has done away with the need of special sex seasons for breeding purposes." That the breeding seasons in the lower animals are largely governed by environmental conditions is an accepted fact.

Up to the time of the discovery of the human ovum, in 1832, there was no reason to associate menstruation with ovulation or even with the reproductive process, and it was not so associated. It is true that a number of earlier authors spoke speculatively of the migration of the ovum through the tubes and of changes in the uterine mucosa preparatory to the implantation of the egg. It is also true that as early as 1831 Negrier had asserted the dependence of menstruation upon the presence of the ovaries. It was not, however, until 1863 that a cohesive theory of the nature of this ovarian influence was conceived by Pflüger. Incorrect though we now know it to be, the theory may be looked upon as the "hopping-off place" in the consideration of the subject from a more modern standpoint. It was the culmination of the speculative era in the history of this subject.

The point of chief interest in Pflüger's concept was that the indispensable influence of the ovaries in the production of menstruation was considered to be exerted through the medium of the nervous system. The pressure of the growing follicles in the ovary upon the surrounding ovarian nerve filaments was believed to give rise to an afferent impulse which, acting through an assumed center in the lumbar cord, in turn engendered an efferent impulse responsible for the pelvic hyperemia, which in turn expressed itself as menstruation.

While it was by far the most generally accepted theory of its day, it was by no means the only one. Lawson Tait, for example, was a staunch believer in the so-called "tubal nerve" as the cause of menstruation. Johnstone explained the process as due to the erect position of human beings, in contradistinction to the horizontal posture of the lower animals. It was in this unsettled era, too, that Sigismund, supported by His, enunciated the view that "women menstruate because they do not conceive," although the dictum itself is to be credited to Powers. That it was in prophetic harmony with the modern viewpoint will be brought out in succeeding chapters.

It was during this speculative era, too, that the doctrine of the "menstrual wave" was promulgated. According to this view, the vital functions of women manifest a wavelike course, with a fall just after menstruation and a gradual increase thereafter, with the acme at the onset of the next period. This concept was championed especially by Mary Putnam Jacobi, Stephenson and Raciborski. While it offered no explanation for the cause of menstruation, the theory is of interest because, as we shall see, evidence is accumulating to indicate that the menstrual flow, instead of being a merely pelvic phenomenon, is really only a local manifestation of a profound rhythmic change affecting the entire organism.

The beginning of the modern endocrine viewpoint of menstrual physiology dates from the work of Knauer and others toward the very end of the nine-

which had been presupposed for it. There has been ample confirmation of this demonstration, so that it has attained general acceptance. Another contribution from the laboratory study of reproductive physiology throws doubt upon the indispensability of ovulation to the occurrence of cyclical bleeding. This evidence has been adduced chiefly by studies upon monkeys by Corner, Hartman, Allen and others. Furthermore, as will be discussed in the appropriate chapter, the belief that the ovum itself is the regulator of menstrual periodicity—the doctrine of the "primacy of the ovum"—has been clearly disproved by the studies of the past few years.

The final chapter in the history of our knowledge of reproductive physiology, so cursorily sketched here, revolves about the newly demonstrated importance of the anterior lobe of the hypophysis in the cycle. For this brilliant advance we are chiefly indebted to Philip Smith, with Engle as a co-worker, in this country, and Zondek and Aschheim in Germany. The governing rôle of the anterior pituitary over the ovary is now a demonstrated fact, and already evidence has been accumulated to indicate a duality of this control corresponding to the duality of function of the ovary. The details of this subject, however, together with a discussion of other aspects not touched upon in this brief historical résumé, will be considered in later chapters.

(For references, see other chapters in this section.)

no pelvic examinations were made in this series of patients. Chisholm adds that, although there were 77 per cent in which pelvic discomfort was a symptom, in 45 per cent the discomfort was only slight or occasional.

The study of Maria Tobler[37] is of more value, inasmuch as the appraisal of the subjective discomfort is made with due regard for the pelvic findings. The series embraced 1020 women, of whom 15.8 per cent were free of any local or constitutional discomfort. In this group 58 per cent suffered with uterine or adnexal disease of one form or another. Of 44 per cent with only local discomfort, 65 per cent had normal pelvic organs.

Finally, I may mention the study of Hodge on 974 ostensibly healthy girls in the Public Athletic League of Baltimore. For these figures I am indebted to the director of the League, Dr. William A. Burdick. In this series 68.8 per cent of the girls experienced no pain, while a greater or less degree of pain or discomfort was experienced by 31.2 per cent. In only 24.1 per cent of all the cases, however, was the pain other than occasional or slight, and in only 5.3 per cent was it severe enough to put the patient to bed for one or more days each month. The cases of this last group are certainly pathologic from a clinical standpoint, and some may have shown pathology in the pelvic organs as well, had pelvic examination been made.

Numerous other studies of this sort have been made (Schäffer, Ketcham, Sanderson, etc.), leading to the conclusion that normal menstruation may be painless, that it may cause only heaviness and bearing down in the pelvis, or that it may cause moderate, but not incapacitating pain. When pain is very severe it must be interpreted as pathologic, from either the local or the constitutional standpoint.

Other Subjective Symptoms.—With regard to these, there is the same difficulty in demarcation between the normal and the pathologic. Many, perhaps most, menstruating women suffer with more or less *lassitude*, at times *irritability*, and in some cases *depression* and *nervousness*. There is often some *soreness of the breasts*, and at times sharp, shooting pains. *Bladder irritability* is quite common just before and during menstruation, probably as a result of pelvic hyperemia. *Headache* is not infrequent, and there may be some *loss of appetite* and *impairment of digestion*, with often an unpleasant odor of the breath and *constipation*. A slight swelling of the neck may be occasionally noted, because of *increase in the size of the thyroid*. Some women exhibit "dark rings" under the eyes, and occasionally *skin eruptions*, especially acne-like pustules, may occur on the face, neck and chest.

It is generally accepted that *libido sexualis* is diminished during the menstrual periods, though this may be the result of esthetic rather than physiologic factors, as Havelock Ellis and Gehring believe. On the other hand, most authors (Krafft-Ebing, Adler) believe that there is an increased sexual sense in the premenstrual period, as well as just after the flow.

The So-called "Menstrual Wave."—In 1878 Mary Putnam Jacobi,[15] in her Boylston prize essay on "The Question of Rest for Women during Menstruation," enunciated the theory that the body activities of women exhibit a wavelike periodicity, with the crest just before the onset of menstruation, and a fall during the latter, with a gradual rise to the next acme. Similar views had been previously expressed by Raciborski (1868) and Stephenson (1872). Since these early papers, numerous studies have been made to show the effect of the menstrual cycle upon various body functions.

kin,[25] from the study of 8 patients, concludes that this is not the case. This view is shared by the skeptical Viville,[24] on the basis of dynamometer tests in 41 women. Moore and Barker, on the other hand, found a slight decrease in muscle power during menstruation, with an increase in the interval and premenstruum.

The effect of the cycle upon the knee-tendon reflex has been studied by King,[23] who concluded that "a period of hyperexcitability immediately precedes or accompanies the onset of the menstrual period; this is followed by a decline in excitability which continues for a few days after the menses have ceased; and there is then a tendency for it to rise to a slightly higher level than the preceding during the intermenstrual period."

The Blood Picture during the Cycle.—*Specific Gravity.*—This is said by Sfameni to show a slight decrease during the premenstrual period.

Red Corpuscles.—Most authors are agreed that there is an increase in erythrocytes in the premenstrual period, a decrease during the flow, and a gradual increase thereafter (Pölzl, Blumenthal, Carnot and Deflandre, etc.). The decrease during menstruation may, according to Blumenthal,[7] reach one million per cubic millimeter. As Gumprich[13] points out, however, almost all the studies which have been made are vitiated by the smallness of the material studied, and the fact that, in many instances, the women have been studied during only one period. She herself finds that the variations in erythrocytes, while they occur, are rarely higher than a few hundred thousand per cubic millimeter.

Hemoglobin.—Pölzl[29] and Gumprich[13] both believe that only slight fluctuations occur in the proportion of hemoglobin. Others believe that there is a slight increase just before and a decrease during the flow, as with the erythrocytes.

Leukocytes.—Gumprich's[13] studies lead her to the conclusion that the leukocytes reach their maximum on the first day of the flow, after which there is a rather sharp drop. She cautions against overemphasizing this change, however, because of the well-known fluctuations in the leukocyte count produced by numerous physiologic factors, such as digestion and exercise. Failure to evaluate these factors is no doubt responsible in large part for the discrepancies in the reported findings. Hayem[14] and Dirks,[5] for example, find an increase of leukocytes during menstruation, while Blumenthal,[3] in a very small group, found a decrease.

The same discrepancies are encountered as regards the differential study of the leukocytes, some finding no characteristic effect (Birnbaum, Neusser), some a decrease in the proportion of polynuclears (Blumenthal), some an increase of lymphocytes (Dirks), etc. In the main the reports are so contradictory as to deserve no especial stress.

OBJECTIVE PHENOMENA OF MENSTRUATION

Periodicity of Flow.—Roughly speaking, about 4 out of every 5 women menstruate at intervals of about twenty-eight days. Minor variations of a day or so more or less are included in this figure, and calendar records of the menstrual dates show these to be very common. This applies, of course, to the mature woman whose menstrual rhythm has been established, for marked irregularities are common during the first few years after puberty and during the menopausal years, as has been discussed elsewhere.

plate. Closer analysis shows that two different kinds of elevation are represented.[2] Those of the early months are so-called *decidual pillars* which represent portions of the compact decidua spared from erosion during the formative period of the placenta. As a consequence, they are irregular in distribution and relatively short; they are not seen beyond the middle of pregnancy. In the later months larger *placental septa* are brought into existence (Fig. 218), presumably by the faster rate of horizontal growth of the uterine wall in comparison to the chorionic membrane. This results in the production of decidual folds between the rapidly enlarging villous trees. The placental septa, therefore, mark off the *cotyledons*, some fifteen to twenty in number, and incompletely separate them. Each cotyledon is a natural

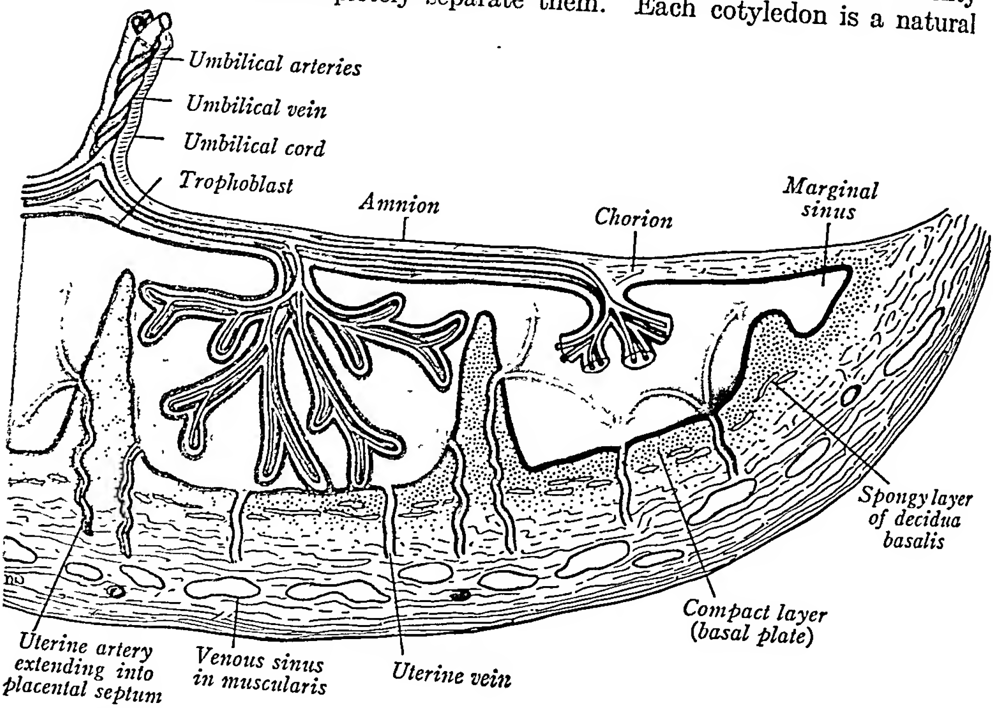

Fig. 218.—Diagrammatic vertical section through one half of a human placenta *in situ* to demonstrate the scheme of circulation. Only one chorionic villus and the stump of another are shown extending into the intervillous spaces of cotyledons. (Arey, 'Developmental Anatomy.')

unit, since it contains a main villous tree which distributes its smaller branches and twigs throughout the cotyledonary area (Fig. 218).

The uterine arteries and veins pass through the basal plate obliquely, losing their accessory coats as they proceed. The arteries course spirally and were formerly believed to open on or near the septa while the veins were held to arise more centrally in the cotyledons (Fig. 218). Such an arrangement might be thought to favor somewhat the effective intervillous circulation of blood. However, this anatomical arrangement is no longer credited, and even the existence of arteries opening into the placental sinus is a matter of doubt, as will be discussed presently. As the placenta increases in size the vessels grow larger; the floating ends of free villi are fre-

the reproductive process are grouped together under the head of "*secondary sex characteristics.*" These include such changes as appear in the mammary glands, the distribution of hair and adipose tissue, the skeletal development, the size of the larynx, etc. The cause of these is generally thought to be the endocrine activity of the gonads. Some authors, notably Tandler and Gross,[7] do not share this view, chiefly on the ground that certain sex differences are discernible long before the inauguration of ovarian endocrine activity at puberty. On the other hand, there is reason to believe that even before puberty the ovaries exhibit some endocrine function, although this becomes far more pronounced when the puberty impulse itself becomes operative, presumably as a result of hypophyseal activity.

General Body Changes of Puberty.—As already stated, the occurrence of the first menstrual period is only one of the manifestations of puberty. Before menstruation actually occurs its imminence is often indicated by other phenomena to be noted in the body and the psyche of the girl. Whereas, up to this time, the girl often possesses a lanky, angular build like that of her brother, with the approach of puberty her figure becomes softer and more rounded, with deposits of fat about the hips and breasts. The latter become much fuller and more prominent, and slight shooting pains may be noted. The entire figure becomes somewhat more rounded as a result of a diffuse deposition of adipose tissue.

A growth of hair appears on the pubes and labia majora, as well as in the axillae. Change of voice is of course much less striking than it is in the male. With these bodily phenomena, there is also a development of definite sex consciousness. There may be also some nervousness and irritability, although these are rarely marked unless the general health is below par, or unless the menstrual period is accompanied by severe pain.

Local Changes in the Generative Organs.—Marked developmental changes are seen throughout the entire generative tract. The *labia majora*, chiefly through the acquisition of fat, become large and prominent, while, as already stated, a heavy growth of curly hair appears on their outer surface, extending anteriorly to cover the *mons veneris*. The latter likewise becomes more prominent through the deposition of fat. The *labia minora* become partly concealed within the oval of the labia majora. In the young child the latter are scarcely recognizable, so that the lesser labia, to all intents and purposes, form the outer margin of the vulva. The *vagina* is somewhat lengthened, and its mucosa becomes more vascular and velvety.

The *uterus* exhibits perhaps the most striking alterations. To appreciate these, one must remember that in the child before puberty the uterus measures usually about 2.5 cm. in length, and that it is made up chiefly of cervix. The corpus is present only as a small nublike convexity, its length perhaps only one fourth to one sixth of that of the entire organ. With puberty, however, the corpus uteri undergoes a striking hypertrophy so that a large well-rounded fundus is developed, constituting from one third to one half of the entire uterus. The muscular walls become thicker, as does the endometrium. The latter, with the onset of puberty, begins to undergo the regular cyclical histologic changes of menstruation, described in a previous chapter.

The *tubes*, which, before puberty, are of small caliber and very convoluted, become wider, more vascular and straighter. The tubal mucosa, like that

among 10,000 female infants, while others give a much greater proportion. If the histologic method of study were employed, searching for blood corpuscles in the vaginal secretion with the microscope, the incidence would no doubt be very high. By this method, for example, Halban found it in no less than 8 of 21 cases, a proportion of 38.09 per cent.

The bleeding is usually slight, but occasionally quite profuse. Its mechanism is different from that of normal menstruation, for, unlike the latter, it is apparently not due in any way to the activity of the infantile ovaries, but rather to endocrine products emanating from the maternal ovaries and placenta.

Incidence and Age of True Precocious Menstruation.—The number of reported cases of this phenomenon is not great. Lenz was able to collect only 130 cases in the literature from 1680 to 1913. Since then a rather large number of additional cases have been recorded. It may occur at any age from birth up to eight or nine years. Lenz's table of distribution, according to age, of the 130 cases which he collected, is as follows:

	Cases.
At the time of birth	1
Immediately after birth	2
2 days after birth	1
14 days after birth	1
15 days after birth	1
2 months after birth	1
3 months after birth	3
4 months after birth	4
5 months after birth	2
6 months after birth	3
7 months after birth	3
8 months after birth	1
9 months after birth	9
10 months after birth	2
1 year	9
1¼ years	1
1½ years	11
1⅓ years	1
2 years	10
2¼ years	1
2½ years	1
2¾ years	1
3 years	14
3¼ years	1
3½ years	2
4 years	13
5 years	6
5¾ years	1
6 years	5
6½ years	2
7 years	2
Exact time unknown	14
Total	130

Causes and Types.—In some cases of precocious menstruation, especially in those in which the precocity is not extreme, the patients are otherwise perfectly normal, and the abnormally early menstrual awakening is accompanied by the general bodily changes characterizing normal puberty. In instances of this type we are apparently dealing with individual vagaries

In at least a small group of cases, pregnancy has occurred. The most remarkable instance, perhaps, is that of Mandeslo,[29] whose patient began to menstruate at three and gave birth to a son at the age of six. Another notable case is the frequently quoted one of Anna Mummenthaler, reported

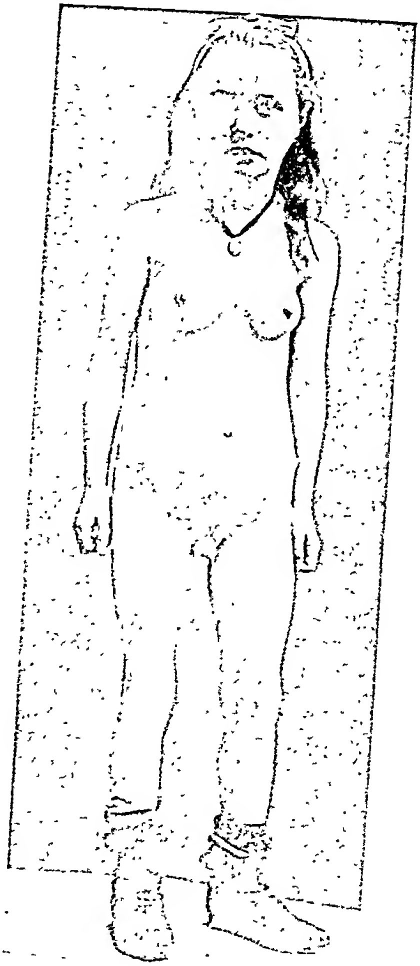

Fig. 116.—Precocious development in a girl of six. The size and general development are those of a child of at least thirteen. Menstruation had been regular since the age of six months, the periods lasting three or four days. Note the development of the breasts. (Lenz.)

by von Haller[29] in 1751. This patient began to menstruate at two, was delivered of a child at nine, continued to menstruate up to the age of fifty-two, and died at seventy-five.

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CHAPTER VI

THE MENOPAUSE (CLIMACTERIUM, "CHANGE OF LIFE")

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The reproductive period of a woman's life embraces a span of about thirty-three years, during which the menstrual function continues. It comes to an end with the cessation of menstruation at the *menopause* or *climacterium*. The disappearance of the function is only one of the manifestations of this epoch, which is characterized by retrogressive phenomena in the genital organs and their accessory structures.

In the minds of the laity, the "change of life" is a critical period of the woman's life, and one fraught with no little danger to her. For example, a rather prevalent belief, particularly among the more ignorant class, is that insanity is not infrequently caused by the menopause. Another and more dangerous misconception is that excessive bleeding at the climacterium is a normal occurrence, some believing that such blood loss prevents the "blood going to the head." I need not stress the dangers lurking in these latter misconceptions, which are directly chargeable with a rather considerable fraction of the mortality from uterine cancer, because of the deadly delay in diagnosis and treatment for which they are responsible.

Age at Which Menopause Occurs.—Many years ago Webster set forth the statement, still to be looked upon as approximately correct, that "in temperate countries the menopause takes place in about 50 per cent of women between forty-five and fifty; in 25 per cent, between forty and forty-five; in 12½ per cent, between thirty-five and forty; and in 12½ per cent, between fifty and fifty-five." One of the most exhaustive studies of this question was made by Sanes,[25] who collected statistics from thirty-two nations. He found the average age to be 47.1 years. Schröder[23] gives an average for German women of about the same age, viz., 47.26 years, as does Mayer[23] (47.04 years). For the French, Leudet[23] found the average age to be 47.4 years for women in comfortable circumstances, 48.7 years for the hard-working classes, and 47.9 years for country women. Tilt's[30] figures, on 1082 English and French women, gave an average of 45.7 years. For Russian women Rodsewitch[28] gives an average of 48.7 years, and for Danish women an average of 44.82 years was found by Hanover.[23]

The statistics given above can be considered only approximately correct, inasmuch as none of them are based upon the study of normal women alone. In other words, they take no account of the possible presence of pathologic conditions, local or general, which might have a very marked influence upon the age of onset of the menopause. Aside from these definitely pathologic cases, there are a number of other factors which may influence the age at which the climacterium appears, although opinions differ concerning a number of them.

women, long after the menopause, the presence of such tumors should be suspected, especially, of course, if no evidence of malignancy is found in the uterus. This subject is more fully discussed elsewhere (Chapter LXII).

Symptoms of the Normal Menopause.—It should again be emphasized that *cessation of the menstrual function* is only one of the manifestations of the menopause, although, from the woman's standpoint, the most conspicuous one. In some cases the function is terminated quite abruptly. Much more frequently, however, the cessation is a more gradual one, with periods of amenorrhea of longer or shorter duration before permanent amenorrhea ensues. The amount of flow at the periods during this transition period may be normal or increasingly scanty, but it is not infrequently larger than normal, even within the limits of normality. In our campaigns of popular education against cancer, we quite properly stress the fact that excessive bleeding may be a sign of malignancy, but it is nevertheless true that moderate excess may occur as a result of the hormone imbalance characterizing this phase (see Chapter LXXI). *Intermenstrual bleeding, however, is never a normal accompaniment of the menopause.*

Vasomotor Symptoms.—By far the most characteristic of the subjective symptoms of the menopause are the rather remarkable vasomotor phenomena seen in varying degree in by far the largest number of patients. Most constant are the *hot flushes,* involving chiefly the head and neck. In some patients these are mild and infrequent, but in others they may be frequent and so severe as to make the patient extremely miserable. The patient's face, neck, and often the upper part of the chest become bright red, and she feels hot and suffocated. The flush is short and transitory, and is often, though not always, succeeded by a profuse sweat. In the milder forms perhaps only an occasional flush is observed, but in the more severe types there may be fifteen or twenty during the day, and perhaps a good many during the night. These nocturnal flushes are especially troublesome, disturbing the patient's rest, and tending to make her nervous and irritable.

The mechanism of these flushes is still obscure. Various theories have been advanced, but none has achieved general acceptance, and most of them are purely speculative. The fact that these flushes so characteristically affect only the regions of the head and neck suggests that the disturbance involves the cervical sympathetic nerves, but just how cannot be stated. The problem is obviously a difficult one to attack experimentally.

The *flashes of heat* of which many menopausal women complain are much less frequent than the flushes, and they are equally difficult of explanation. They occur usually as hot tingling waves affecting perhaps the entire body, and, like the flushes, are very transitory. *Sweats* are often complained of, occurring usually immediately following the flushes, but at times independently.

An objective finding presumably associated with vasomotor disturbance is a *moderate rise of blood pressure.* One must of course be cautious in ascribing hypertension to the menopause, particularly in view of the great frequency of pathologic hypertension at the middle period of life. Nevertheless, one not infrequently sees patients with systolic pressure of perhaps 150 to 160 mm. during the changing years, with a drop to a considerably lower figure once the menopause has been passed. Climacteric hypertension of this sort has apparently achieved the general acceptance of internists.

minute to several centimeters in diameter. These nodules are the so-called "infarcts" or, as they have been variously termed, "hepatization," "scirrhus," "placentitis," "apoplexy," "cirrhosis," and "phthisis."

Several *varieties* have been described and their mode of origin has given rise to a huge literature, out of all proportion to their clinical significance. J. W. Williams described six kinds of infarcts, and the number has been raised or lowered by other observers. The whole subject has been materially clarified by the excellent paper of Siddall and Hartman[17] which is freely quoted here. Failing to find satisfactory names for the special forms of infarcts, these writers have divided them into four groups by number as follows:

1. Infarcts of the first type are poorly defined, or even very irregular, pearl-gray formations occurring usually in the depths of the placenta but at times also near the surfaces and margins. They may vary from a few millimeters to several centimeters in width and occasionally are so large as to extend from surface to surface. We have never seen massive involvement

Fig. 223.—Placenta from abortion at the fourth lunar month, showing an early infarct of the first type. (Siddall and Hartman in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

as sometimes occurs in the last type. There are no striations, but there is often a mottled appearance near the outside due to the partial inclusion of small areas of normal placental tissue (Fig. 223).

Microscopical examination of an advanced infarct of this kind shows that at the edges there are broad projections of fibrin extending outward to outlying and nearly normal villi, while toward the center the structure becomes solid and consists more and more of degenerated shadows of villi surrounded by old fibrin, fragments of nuclei alone suggesting the original cellular structure. Evidently, the deeper portions are distinctly older, and examples are easily found showing development by peripheral involvement of villi with fibrin projections from a nucleus of several villi matted together by fibrin.

2. Sharply demarcated, usually rounded or oval bodies, occasionally roughly quadrilateral, varying in diameter from a few millimeters to several centimeters and in color from red, brown, or almost black to pink or brick

upon the villi with localized epithelial defects and is aided by the slowness of the blood stream in the maternal circulation.

Paddock and Greer[19] feel that the small placental cysts present in practically all placentae and having their origin in the decidual septa or so-called "decidual islands" are formed by action of trophoblastic cells on decidual tissue. They believe that these cysts are always associated with some degree of white infarction and are in all probability the cause of the white infarcts with which they are associated.

The types 2 and 3 of Siddall and Hartman while differing greatly in appearance from the white infarcts just described, probably all represent different phases of the same anatomical change. Probably they are formed by rapid coagulations of blood in layers against older degenerated areas, normal villi being pushed back as the masses increase in size.

The infarcts of type 4 are probably examples of true infarct formation in the ordinary sense, being due to a disturbance of the fetal maternal circulation.

The *frequency* of infarct formation is noteworthy, since in Siddall and Hartman series of 700 placentas there were 67.7 per cent presenting infarcts of some kind, measuring at least 5 mm. in diameter, and it is probable that many more showed these defects of microscopical dimensions.

Thoms,[20] who studied 58 placentas by injection, section and roentgen photographs, says that marginal white infarct formation is so common that it may be considered a normal phenomenon of the mature placenta.

Clinical Significance of Placental Infarcts.—The older writers laid great stress upon the interference with fetal oxygenation which might be produced by extensive infarct formation and cases are recorded wherein the death of child *in utero* was presumably caused by such diminution in oxygenative surface (Fig. 227).

In Thoms' series, however, 17 per cent were found infarcted to a degree which actually interfered with the placental circulation. In one case 24 per cent of the placental circulation was thus arrested by the process, yet there was no evidence of maternal toxemia or ill effect upon the baby; and the conclusion is identical with that of Siddall and Hartman from their much longer series. Furthermore, infarct formation seems to bear no relation to the growth and weight of the child as shown by several series of statistics.

The writer has long felt that the tremendous factor of safety provided for by nature in all of her processes must and does apply to the placenta, and that all possible contingencies are so provided for short of complete catastrophic breakdown, as, for example, abruptio placenta.

The Relationship of Infarction and the Toxemias of Pregnancy.—Here lies a fruitful ground for argument among obstetricians. Most text-books emphasize the relationship. For example DeLee[21] says that infarcts cannot be diagnosed clinically but their existence can be expected in cases of nephritis, heart disease, syphilis, endometritis and when they were present in previous pregnancies. In Siddall and Hartman's series there was some increase in the size and number of the infarcts in toxic cases, but these authors believe with Young, that such higher incidence is a consequence of the toxemia rather than the cause, and results from an intervillous stasis following upon the more marked changes in the uterine vessels.

In Thoms' small series there was no definite relationship and as this

CHAPTER VII

CYCLICAL CHANGES IN THE GENITAL CANAL

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Historical.—Up to 1908 the endometrium had been described as a tissue of fixed, stereotyped histologic structure. The chief point of discussion seemed to revolve around the question of whether or not there is any loss of endometrial tissue at the time of the menstrual periods. It is true that certain early investigators foreshadowed subsequent discoveries by describing variations at various epochs. For example, Kundrat and Engelmann,[16] as early as 1873, spoke of a widening of the glands, with dilatation of blood vessels and infiltration with round cells, as characterizing the endometrium just before menstruation. This work was based upon cadaver material alone. Somewhat similar findings were described by Leopold (1885),[18] also on the basis of postmortem material. The problem was also studied by Williams (1876), De Sinéty, Wyder and others.

Williams[36] believed the uterine mucosa to be entirely cast off at menstruation, but his conclusions were vitiated by the fact that his material was obtained altogether from autopsies, and that a considerable number of his patients had died of acute infections. Möricke's work (1882)[21] was not open to such objections, for his material consisted of curettings from women at various known stages of the cycle. He believed that there is no loss of tissue at menstruation.

The most careful work of this earlier era, however, is to be credited to Westphalen (1896),[35] who studied both scrapings and freshly extirpated uteri. Indeed, it may be said that Westphalen's studies, in many ways, foreshadowed the later important contribution of Hitschmann and Adler. He was able to describe a definite developmental process in the uterine mucosa, beginning about ten days before the period, and characterized by gland hypertrophy, secretory activity and hyperemia. With menstruation comes a loss of tissue, followed by a period of regeneration, which, however, he thought not complete until the fourteenth or fifteenth days.

The well-known theory of Gebhard,[7] quite generally accepted up to recent years, embodied a division of the cycle into three phases, viz.: (1) Premenstrual congestion; (2) external hemorrhage; (3) postmenstrual regeneration. During the bleeding phase, subepithelial lacunae of blood are formed, lifting the surface here and there, but, according to Gebhard, there is no characteristic or extensive loss of the endometrium.

It was not until 1908 that Hitschmann and Adler,[11] through a systematic study of uteri removed at various phases of the cycle, were able to demonstrate beyond all doubt the histologic cycle of events in the endometrium, and their description, with minor additions, is the one universally accepted today. Only with reference to the stage of actual menstrual bleeding were their observations incomplete and perhaps faulty, and it remained for Schröder[29] to fill in this deficiency (1915). This investigator demonstrated clearly

Cyclical Changes in the Endometrium.—Our modern knowledge of this subject is based upon the investigations of Hitschmann and Adler,[11] published in 1908. A careful study of fifty-eight uteri, removed at various phases of the menstrual cycle, led to a formulation of the histologic picture characteristic of each phase. The division into four phases, suggested by these authors, is still the one in common use.

Postmenstrual Phase.—Just after menstruation the endometrium is characteristically very thin, often measuring scarcely more than 1 mm. in thickness. The newly regenerated epithelium is of very low cuboidal type, but soon increases in height, so that even after a few days it may approach a definitely columnar character. The glands are slitlike in appearance, exhibiting no tortuosity and having very narrow lumina. The stroma is dense and compact.

Fig. 119.—The endometrium in the postmenstrual phase (fifth day of cycle). Note especially the straight and narrow glands. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

In this stage mitoses are often found in the epithelium, and, to a less extent, in the stroma. Indeed, they are more numerous in the week or so

again was ascribed to the high incidence of hydramnion with its consequent frequent premature labor.

Hydramnion.—As has been stated above hydramnion occurred in 32.7 per cent of the collected cases of placental tumor. This excess of amniotic fluid seems to bear a direct relation to the size of the tumor, it being rarely

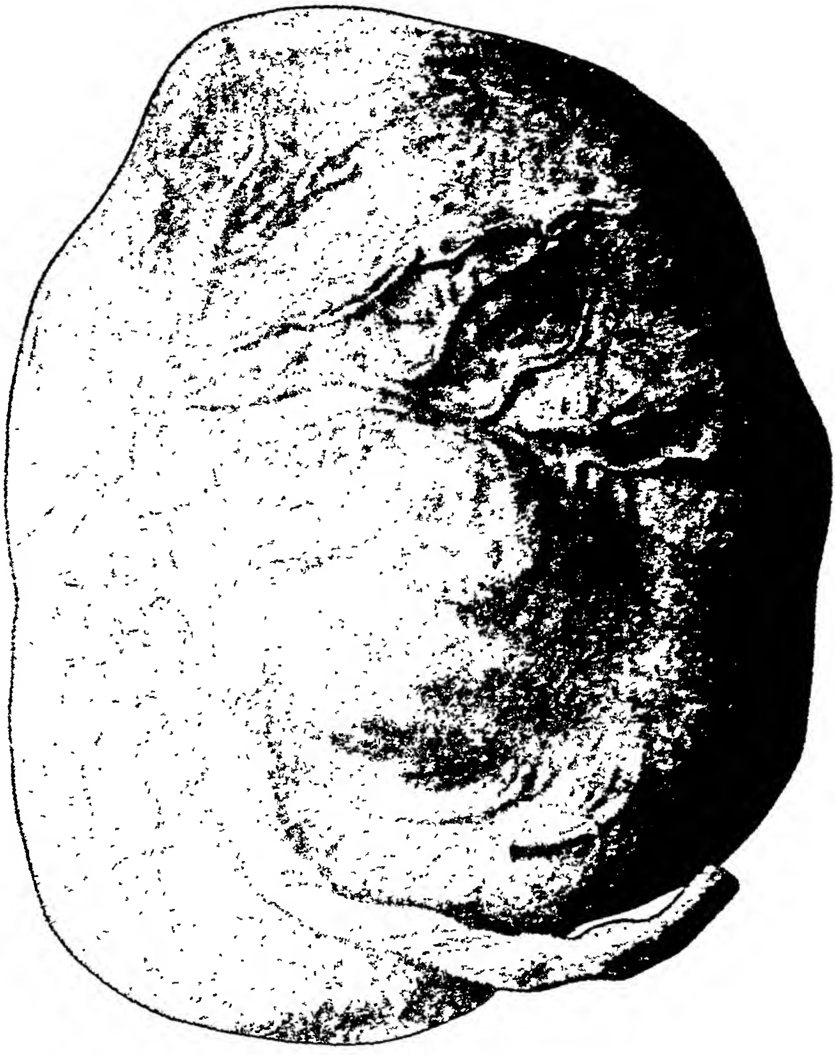

Fig. 232.—Placenta showing tumor elevation on fetal surface. (Siddall in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

associated with small growths while present in 90 per cent of the larger growths.

Summary.—Most tumors of the placenta are chorio-angiofibromata and are rare growths of variable size and benign tendency. Clinically, they have no effect upon the course of pregnancy and labor except that in the presence of large tumors hydramnion, with its associated high fetal mortality due to

During this stage the stroma shows a varying degree of reaction. In some cases there is only a slight, almost imperceptible cytoplasmic increase, with a spreading apart of the cells because of edema, this giving the stroma a looser texture. In other cases these changes are very pronounced, so that the stroma cells, particularly in the superficial stratum, become much larger. Their nuclei may show a very definite band of surrounding cytoplasm, so that, in some cases, they distinctly resemble decidual cells (decidua-ähnlichenzellen), though they will not usually be confused with the frank type of the latter characterizing pregnancy.

Fig. 123.—Endometrium from a patient just about to menstruate (twenty-eighth day), showing marked infiltration of stroma with leukocytes and wandering cells.

There is definite increase of vascularity in this stage, numerous thin-walled venules and capillaries coursing through the endometrium, often in closest proximity to the gland lumina. Another interesting feature is an infiltration with leukocytes and other wandering cells, especially large mononuclears, with very dark-staining nuclei. This infiltration is especially intense immediately before the onset of the period, so that, unless one is familiar with the physiologic nature of this phenomenon, the picture might easily be misinterpreted as indicating an inflammatory change. In this

It, however, becomes important in the regeneration of the endometrium after menstrual desquamation, as will be described below. According to Bartelmez, there is an involution or shrinking of the endometrium by nearly 50 per cent following the leukocytic infiltration above described, and occurring even before the beginning of desquamation and extravasation.

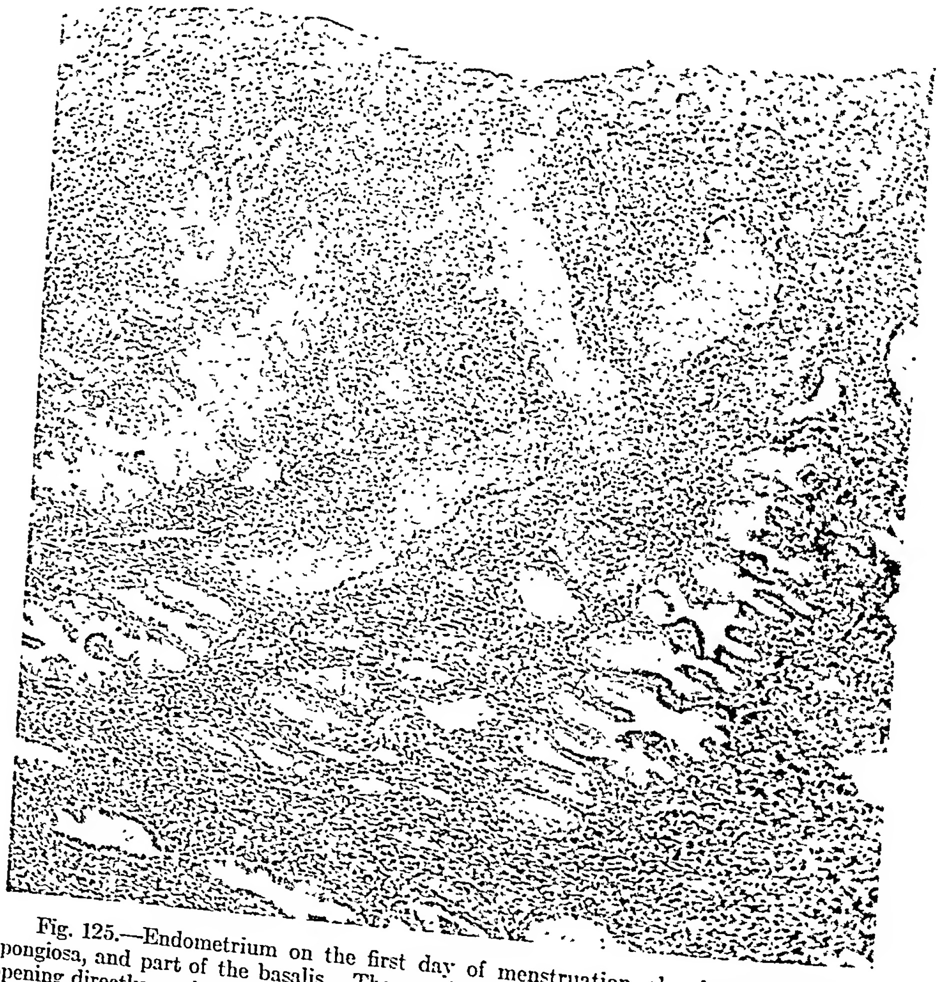

Fig. 125.—Endometrium on the first day of menstruation, showing the compacta, spongiosa, and part of the basalis. The greatly dilated blood vessels, some of which are opening directly on the surface (rhexis), are especially prominent. There is a marked infiltration, especially of the compacta, the upper portion of which is being cast off in small particles. There are considerable individual differences in the degree of this endometrial loss on the first day.

Menstruating or Bleeding Phase.—For a clear idea as to the changes characterizing this stage we are indebted to Schröder[28, 29] more than to Hitschmann and Adler, for it was his work which determined the end of the controversy as to whether or not the endometrium is cast off at menstruation. Some had believed that it is, while others believed that the transition from the premenstrual maximum to the postmenstrual minimum was accomplished

only the basalis, with irregular tags of spongiosa, may be left at the height of the loss. There is apparently some variation in the degree of tissue loss, although it is always quite extensive.

The manner in which the surface is cast off is quite characteristic. It is not thrown off en masse, but crumbles away in smaller masses. Even before the casting off process actually begins, and, indeed, even before the

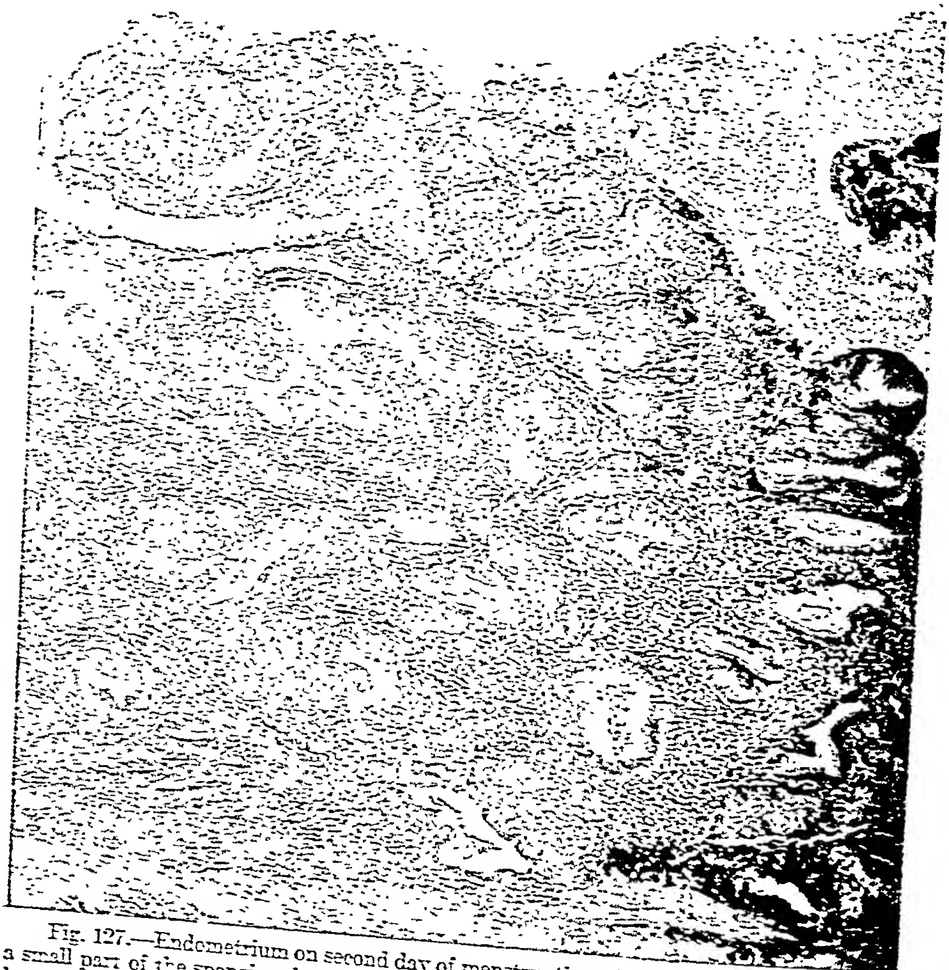

Fig. 127.—Endometrium on second day of menstruation, showing the basalis with only a small part of the spongiosa intact. The compacta and the greater part of the spongiosa have been cast off. (Novak, Nelson, Loose Leaf Living Surg.)

beginning of menstrual bleeding, the necrosis of the superficial layers is indicated by the histologic appearance, for the cells stain poorly and the cell outlines become blurred.

Usually by about the third day the desquamation has been completed, and signs of regeneration are to be seen. As a matter of fact these may be noted even before the devitalized tissue has all been thrown off. The

processes by which this is accomplished. Immediately following the birth of the head and before the body of the child has been extruded, the uterus contracts powerfully with the exception of the placental site. After the expulsion of the fetal body this contraction is much increased until the entire musculature is retracted and much thickened, its cavity being almost completely obliterated. The organ is then practically a solid mass of muscle, in close application to the placenta which remains attached, but which owing to the diminution in its area of attachment has become much thicker than at the onset of labor.

As the uterine contraction and retraction continue a point is finally reached where the inelastic placenta can no longer accommodate itself to the reduced area of the placental site and it is accordingly peeled or squeezed off the uterine wall. This separation takes place within the decidua spongiosa, where lie

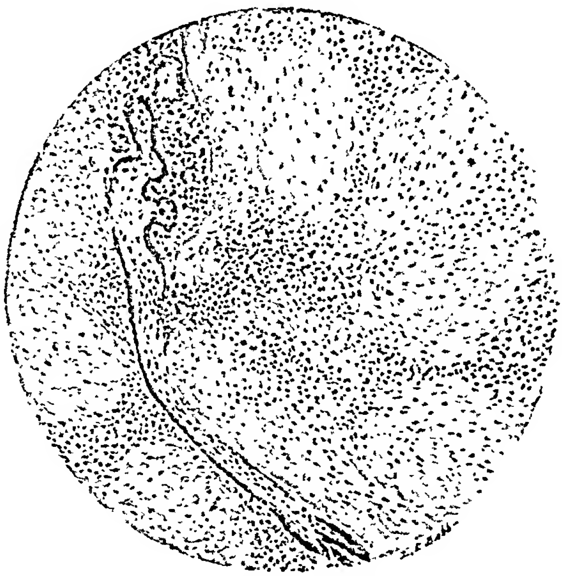

Fig. 239.—Placenta accreta. Villus penetrating muscle. (Polak and Phelan in Surg., Gyn., and Obst., February, 1924.)

the delicate trabeculae and the most dilated vessels. Following this rupture of the spongy layer there rapidly forms a retroplacental hematoma, the pressure of which further accelerates placental detachment.

This separation takes place in the spongy layer of the decidua basalis so that after expulsion there is a layer of the decidua basalis adherent to the placenta, while a portion of this structure remains attached to the uterine wall (Figs. 239, 240).

If the foregoing mechanism be assumed to be correct it will be seen that the presence of a decidua basalis is absolutely necessary to normal placental separation. In placenta accreta, where there is no such decidua present and the villi directly penetrate the uterine wall and make with it one continuous structure in which no line of cleavage can be demonstrated, the placenta cannot separate and hence remains as an integral portion of the uterine wall. Furthermore, in the absence of decidua, the chorionic villi erode

phase. The cells are narrow, closely placed, and, after the first day or so, of uniform height.

2. In the interval phase, the epithelium is uniformly tall, the ciliated cells being broad, with rounded nuclei near the free margin, while the non-ciliated cells are rather narrower, the nuclei being more deeply placed and taking a deeper stain.

3. In the premenstrual phase the ciliated cells become lower, so that the "secretory" cells project beyond them, giving the epithelial margin a

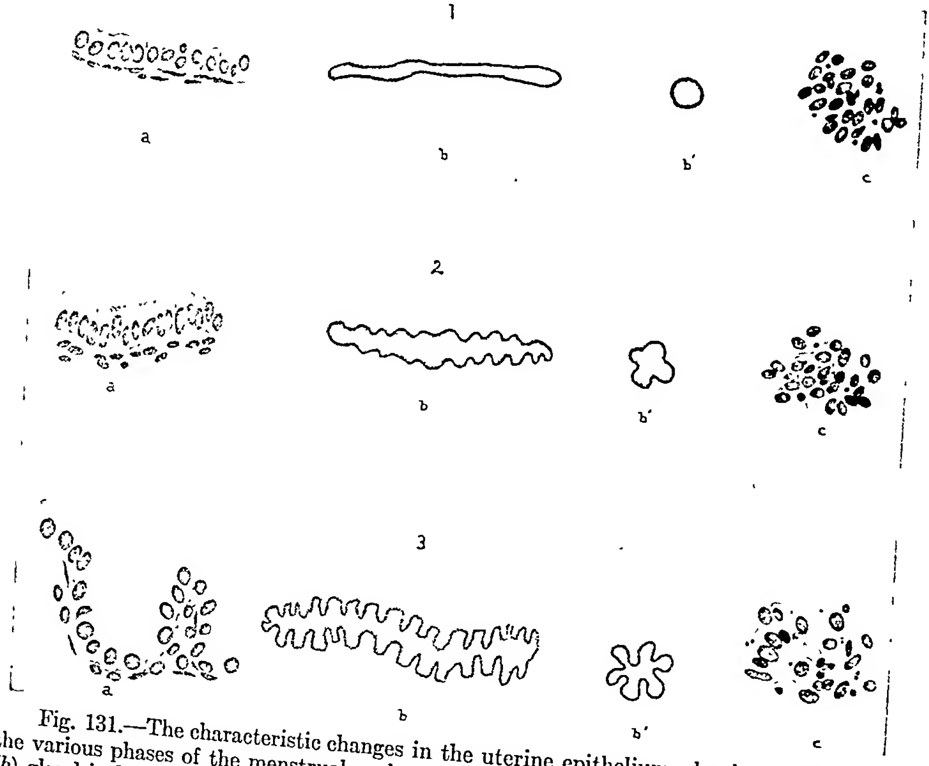

Fig. 131.—The characteristic changes in the uterine epithelium, glands and stroma at the various phases of the menstrual cycle. 1, The postmenstrual stage: (a) Epithelium; (b) gland in longitudinal section; (b′) gland in cross section; (c) stroma. 2, The interval stage: (a) Epithelium; (b) gland in longitudinal section; (b′) gland in cross section; (c) stroma. 3, The premenstrual stage: (a) Epithelium; (b) gland in longitudinal section; (b′) gland in cross section; (c) stroma. N. B. The menstrual stage is not illustrated, as it represents a transition from (3) to (1). (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

ragged, uneven appearance. The "secretory" cells show a bulbous herniation into the lumen of the tube, often carrying the nucleus with it. This extrusion of nuclei is similar to that seen in many lower animals, but its significance is not known. In spite of the great loss of cells, mitoses are rarely seen in the tubal epithelium.

4. During the stage of menstruation, the premenstrual changes are carried further, the epithelium becoming quite low. The ciliated cells, especially, remain broad and low, but the secretory cells also, having been

surface or, particularly, if torn blood vessels are found at the margin of the membrane, this anomaly must be considered and manual exploration of the uterus must be performed in order to remove it.

Placenta circumvallata is a condition in which there is a more or less complete circular ring upon the fetal surface of the placenta at varying distances from its margin. The ring, about 1 cm. in width, is slightly elevated upon the general surface of the placenta, and usually presents a white or yellowish appearance. Usually the ring lies somewhat eccentrically and divides the fetal surface of the placenta into two distinct regions, the central portion bounded by the internal margin of the ring, and a peripheral zone outside the ring. The central area is that of a normal placenta containing the attachment of the cord and the large fetal vessels, which latter are always absent from the peripheral portion of the placenta, their terminal branches

Fig. 243.—Placenta circumvallata. (Author's case, Kensington Hospital for Women, Philadelphia.)

turning directly downward into the substance of the organ before reaching the edge of the ring (Fig. 243).

The mode of origin of placenta circumvallata has given rise to a large literature, there being many theories regarding it. The whole matter has been very well reviewed by Williams,[28] who surveyed the literature and came to the conclusion that the essence of the abnormality lies in the restricted area of the chorionic plate, the folding of the membrane and the presence of a layer of decidua upon the extrachorionic portion of the fetal surface of the placenta. This striking anatomical anomaly has no clinical significance except in its occasional association with widespread placental infarction.

DISEASES OF THE UMBILICAL CORD

Variation in Length of the Cord.—The average length of the umbilical cord is given by Naegele[40] as from 34 to 48 cm. while Lariot[41] gives from 50 to 60 cm. as the normal length. Von Winckel says that the cord is approximately as long as the fetus or about 50 cm. in a mature child.

Very marked variations in length may occur, a cord of 198 cm. having

emptied of their cytoplasm, are much lessened in height, the nuclei often being quite bare of cytoplasm. "Peg" cells are numerous, their appearance and distribution suggesting that they are merely emptied "secretory" cells.

5. During pregnancy, the epithelium becomes even lower than in the menstrual stage, and in the later stages it may become almost flat in many places. Secretory changes are not seen at this time.

Is There a Histologic Cycle in the Cervix?—A priori, we would expect that this would be the case, for the cervical mucosa is a derivative of the müllerian epithelium, like the epithelium of the uterus and tubes, both of which show such characteristic histologic changes during the cycle. As yet, however, no clear-cut cycle has been described in the case of the endocervix. So far as I know, only in the guinea-pig has such a cycle been recently demonstrated, by Hartmann and Olbers (1931).

Fig. 151.—Tubal epithelium at about four and a half months' pregnancy (uterine). Above is seen a distinct decidual nodule in the tubal wall, a rather infrequent finding. Over it the epithelium is very flat, almost like simple squamous epithelium.

According to these authors, the cervical epithelium, in the *di-oestrous phase*, consists of a single layer of columnar cells, with basal nuclei, while the stroma of the tubal folds is quite dense. In the *pro-oestrous phase*, there is definite stratification of the epithelium, which may show as many as six or eight layers. The nuclei are more centrally placed, the stroma is still dense, and the blood vessels are full and congested. The *oestrous phase* is characterized by disappearance of the nuclei, with desquamation of the epithelium, while the stroma is quite edematous. Finally, during the *metoestrous phase*, there are usually two or three layers of epithelium, often vacuolated, while the cervical lumen contains cast-off and degenerated epithelial cells.

Cyclical Changes in Vaginal Mucosa.—Although, in at least some of

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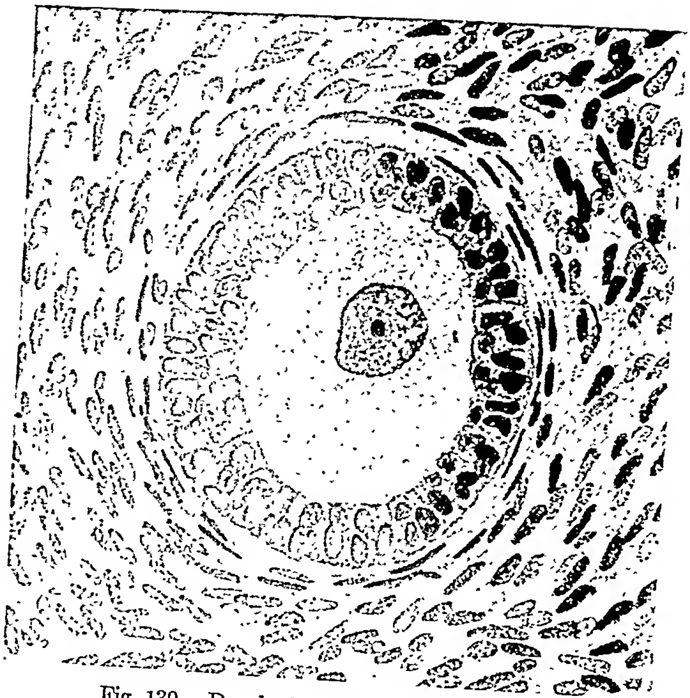

Fig. 139.—Developing follicle. (Williams.)

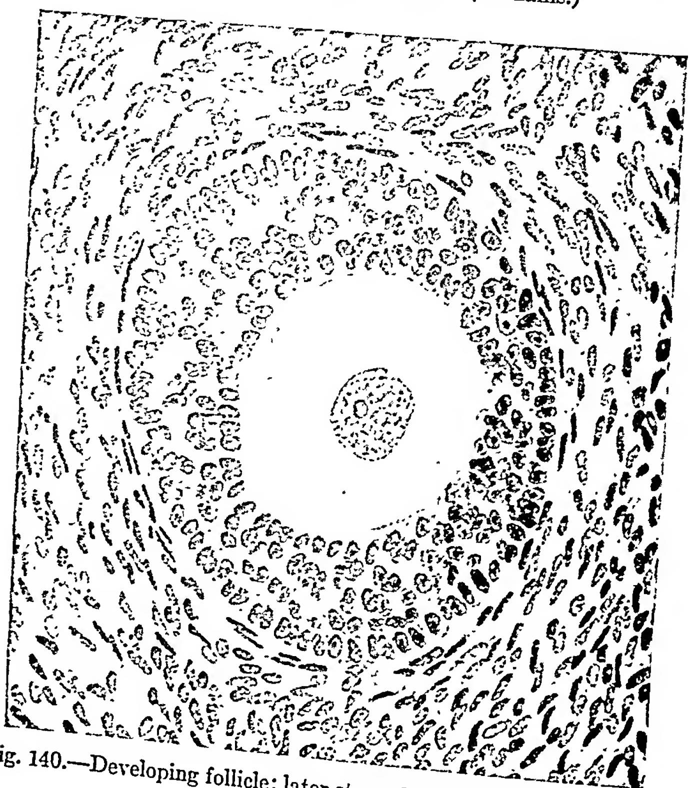

Fig. 140.—Developing follicle; later stage than Fig. 139. (Williams.)

has no blood vessels of its own, apparently deriving its nutrition from the surrounding theca interna, whose cells represent a modification of the ovarian stroma cells. The nutrient function of the theca interna is further suggested by the fact that its cells become larger and show numerous fat globules.

So much for the development of the follicle up to the time of its rupture, with discharge of the ovum, or *ovulation.* At this time, the acme of follicle growth, it is well to remember that the endometrium is in its interval phase, that secretory changes in the endometrial gland epithelium have not yet

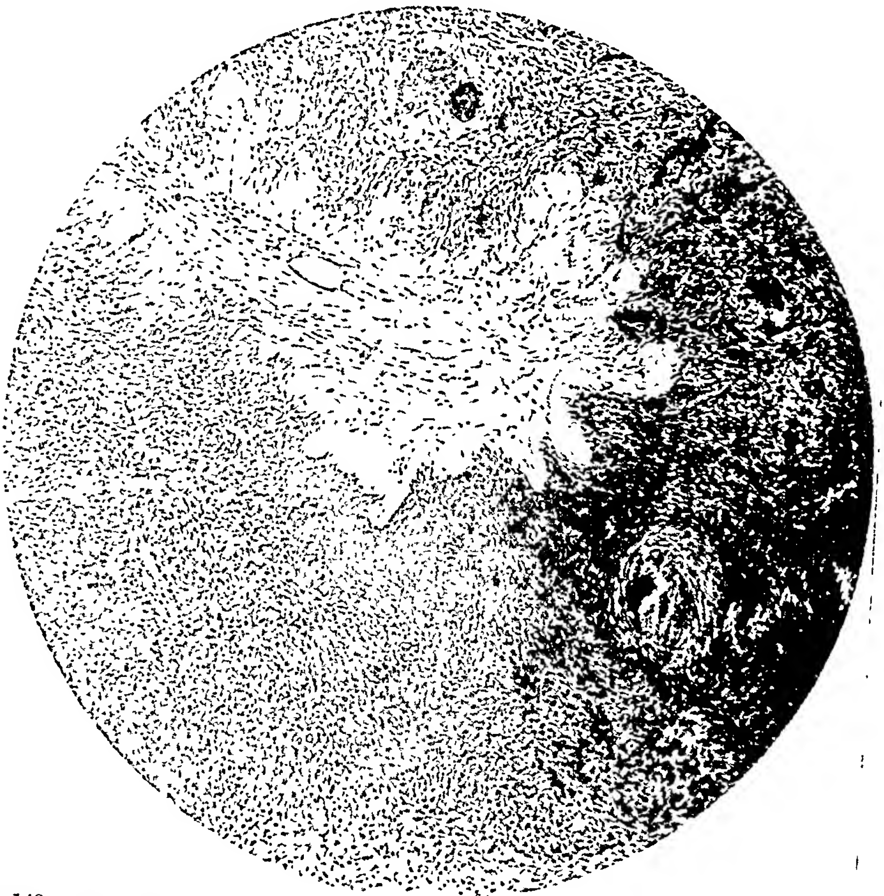

Fig. 143.—The obliterative stage of atresia folliculi, the cavity being practically obliterated with cicatricial tissue (corpus fibrosum).

begun, and that a long period, of approximately two weeks, will elapse before the beginning of menstrual bleeding. In the lower animals, however, the acme of follicle development marks the onset of oestrus, the period of sex desire or heat, at which time, and only at which time, copulation takes place. These two considerations are here emphasized because they typify the important differences, so commonly overlooked, between the oestrous cycle of lower animals and the menstrual cycle of women.

What becomes of the many follicles, aside from the one reaching full

applied to the fetus in utero; the skeletal shadows are of value in determining the size and age of the fetus and also in diagnosing its death. Improved technic will doubtless add greatly to the accuracy of this method. A study and knowledge of fetal skeletal growth and development, and the variations from normal are of great importance to obstetricians not only for the reasons mentioned above but also for the antepartum recognition of the existence of pregnancy, missed abortion, malpositions of the fetus, multiple pregnancies, fetal gigantism, and fetal diseases, as hydrocephalus and such skeletal malformations as are associated with monstrosities. The development of the bony skeleton can be traced by the laying down of the ossification centers, by the fusion of these nuclei, the changes in the shape and size of the growing bones, the fusion of the diaphysis with the epiphysis of the various bones, and by the fusion of the various bones, as is seen in the skull and the pelvis. Approximately 800 centers are laid down to form ultimately the more than 200 bones present in the adult human skeleton. Nearly one half (380) of these centers appear during the antenatal period and about 440 appear subsequent to birth, at which time there are approximately 270 separate nuclei. The number of these centers shows constant variation, not only because of the appearance of new centers but also on account of the fusion of older ones. At the age of six years there are approximately 300 centers, most of which are epiphyseal. The maximum number of separate centers is found at about the time of puberty when about 356 can be identified. About 225 centers appear in the vertebral column and almost an equal number, 280, occur in the appendicular skeleton.

A detailed description of skeletal development would exceed the limits of this chapter. The following table taken from an as yet unpublished report of the White House Conference on Child Health and Protection will give an idea as to the site and time of appearance of the different centers of ossification.

TIME OF APPEARANCE OF CENTERS OF OSSIFICATION

Head	
Mandible	7th week
Occipital bone (squamous portion)	8th "
(lateral and basilar portion)	9th to 10th "
Superior maxilla	8th "
Temporal bone (petrous, mastoid and zygoma)	9th "
Sphenoid (inner lamella of pterygoid process)	9th "
(great wings)	10th "
(lesser wings)	13th "
(anterior body)	13th to 14th "
Nasal bone	10th "
Frontal bone	9th to 10th "
Bony labyrinth	17th to 27th "
Milk teeth (rudiments)	17th to 25th "
Hyoid bone (greater cornua)	27th to 32d "
Body	
Clavicle (diaphysis)	7th week
Scapula	8th to 9th "
Ribs	
Ribs, 5th, 6th, 7th	8th to 9th week
2d, 3d, 4th, 8th, 10th, 11th, 9th	9th "
1st	10th "
12th (very irregular)	10th "

logic types of corpus luteum hematoma may of course be much larger. During the vascularization phase of the corpus luteum the endometrium is in its interval phase. Just as the latter is divided into an early and a late interval phase, so we may speak of an *early* and a *late vascularization phase* of the corpus luteum. The ovarian and uterine phases, however, do not parallel each other, for the early interval endometrial phase, for example, is found even before the follicle ruptures.

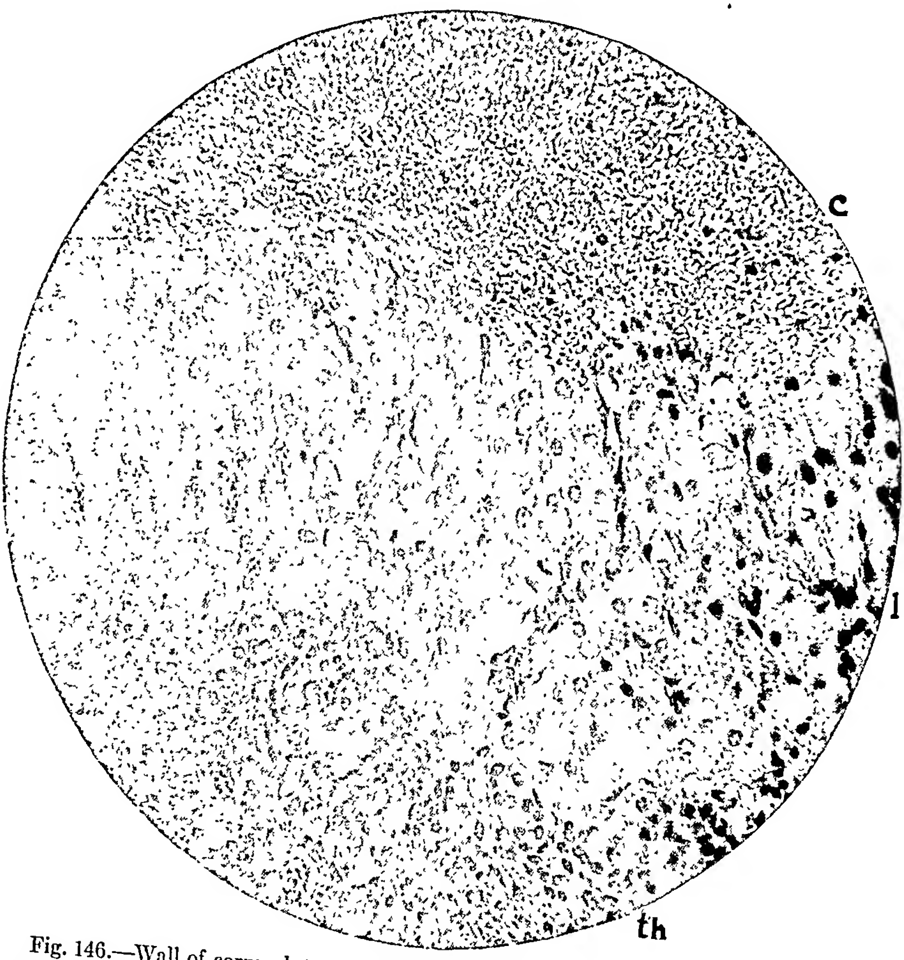

Fig. 146.—Wall of corpus luteum in stage of early vascularization, sixteenth day (high power). Blood vessels from the theca are pushing into the granulosa layer (*l*), which now possesses definite lutein characteristics. The theca cells (*th*) have lost their fat and are retrogressing. Note the beginning invasion of the blood in the cavity (*c*) by endothelial cells. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

3. Stage of Maturity.—As the corpus luteum approaches full maturity, the lutein zone becomes broader and more festooned, the lutein cells being now large, clear, often vacuolated, and of irregular polyhedral shape, with sharply marked round or oval nuclei. Morphologically they resemble closely the cells of the adrenal cortex. Most of the blood in the lumen has been resorbed, though traces of it are often still present. Along the inner or lumen

mature structure is usually recognizable on the surface of the ovary as a moundlike elevation of yellowish hue, with surrounding hyperemia. It may at times be so elevated above the surface as to constitute a virtual polyp. On the other hand, it may be concealed below the surface so that it can be distinguished only by cutting into the ovary. It measures usually from 1 to 2 cm. in diameter, so that it may constitute as much as a third or even

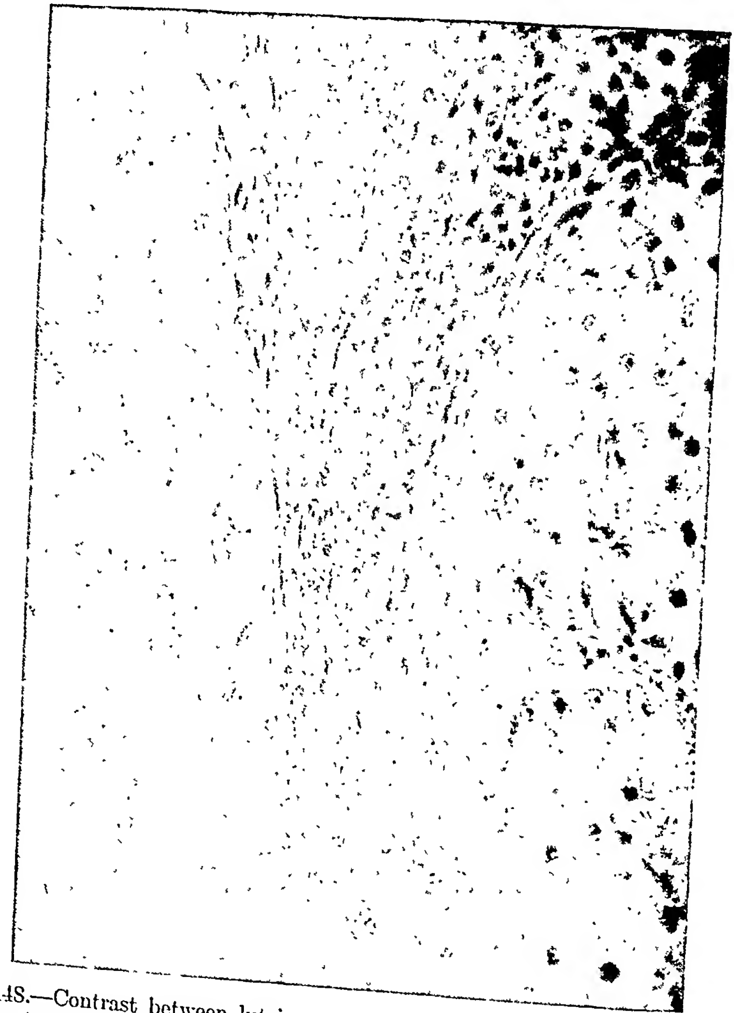

Fig. 148.—Contrast between lutein and paralutein cells, near top of septum shown at *p* in Fig. 147 (high power). (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

a half of the cut surface of the ovary. The yellow color of the lutein zone is dependent upon the presence of a pigment called *carotin*, identical with that found in carrots. There is some variation in the shades of pigmentation from a bright yellow to a reddish-brown.

It should be remembered that the stage of maturity in the corpus luteum corresponds to the premenstrual or pregravid phase of the endometrium,

and, as we shall later see, the latter is now known to be due to the internal secretion of the lutein cells of the mature corpus. Evidences of beginning secretory activity in the endometrial gland epithelium are present even before full maturity of the corpus, as we have already seen, but it is when the corpus becomes fully developed that they are striking.

4. Stage of Retrogression.—Shortly before the onset of menstrual bleeding, the corpus luteum begins to retrogress. It diminishes in size, loses its vascularity, and the lutein zone becomes increasingly fibrotic, with fatty

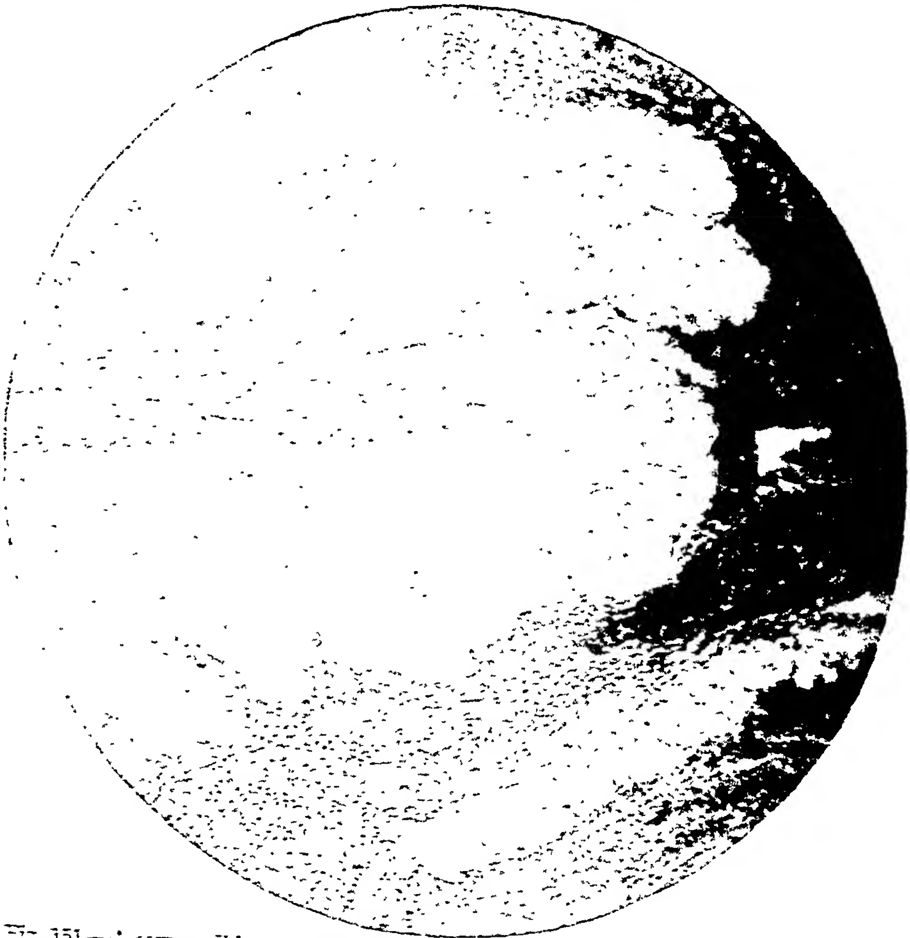

Fig. 151.—A corpus albicans. Note the sharp outline of the hyalinized, festooned, lutein zone. (Novak, "Menstruation and Its Disorders," published by D. Appleton & Co.)

degeneration of the lutein cells. The invasion of fibrous trabeculae from the theca causes increased shrinkage of the lutein zone, while still later hyalinization of the latter is noted. In this stage the lutein zone appears in the stained section as an almost amorphous, glassy and convoluted zone standing out quite sharply, even in its fossilized form, from the surrounding structures. Cicatrization of the fibrous tissue within the lumen obliterates the latter completely. In this retrogressive end-stage the structure is given the name of *corpus albicans* or *corpus candicans*.

Differences Between the True and False Corpora Lutea.—Aside from the larger size and the longer persistence of the corpus luteum of pregnancy, there are other differences between the two structures. These have been perhaps best formulated in the following tabulation, by Marcotty:[16]

CORPUS LUTEUM MENSTRUATIONIS

	Before menstruation.	*After menstruation.*
Blood	Infrequent, small amount.	Regularly, abundant.
Blood pigment	Little.	Much.
Fat	Little, chiefly in theca.	Much, principally in granulosa.
Colloid	Absent.	Absent.
Calcium	Absent.	Absent.
Size of organ	Increasing to menstruation.	Then decreasing.
Size of cavity	Usually small.	Organized.
Connective tissue covering	Slight.	Well defined.
Size of granulosa cells	Average.	Atrophic.
Theca cells	Conspicuously present.	In diminishing number.
Connective tissue framework and blood vessels	Slight.	Marked.

CORPUS LUTEUM GRAVIDITATIS

	First half.	*Second half.*
Blood	Usually not present.	Usually not present.
Pigment	Except perhaps traces.	Except perhaps traces.
Fat	Very little.	More toward end.
Colloid	Frequent, abundant.	Less frequent, less abundant.
Calcium	Absent.	Rather frequent.
Size of organ	Larger than corpus luteum of menstruation.	Smaller than in first half.
Size of cavity	Large, cystic.	Smaller, more frequently solid.
Connective tissue	Very well marked.	Well marked.
Size of granulosa cells	Larger than average.	Smaller than average.
Theca cells	Almost always present, but owing to flattening not conspicuous.	Gradually disappearing.
Connective tissue framework and blood vessels	Fairly well marked.	Well marked.

with perhaps a punctate, hemorrhagic point of rupture. These are, no doubt, in some instances properly construed as very recently *ruptured follicles*, although here again they may be confused with accidentally ruptured atretic follicles. When, however, the follicle is surrounded by a hemorrhagic zone, and when its wall is yellowish in color, there is little doubt that we are dealing with an *early stage of corpus luteum formation*. Later there is no difficulty in determining the presence of corpora lutea, for the cavity becomes definitely hemorrhagic and the lining undulating and bright yellow.

Examination of the ovary at any time during the *few days before menstruation* will often show a definite rounded elevation, occasionally almost polypoid, of bright yellowish color, and with surrounding hyperemia. This is the *mature corpus luteum*. In some instances, however, as in the case of the retrogressive corpus, the mature body is demonstrated with certainty only by cutting into the ovary. It may be so large as to make up a large portion, even one third or at times as much as a half of the cut surface. During this stage the ovary, because of the presence of a large mature corpus, and perhaps also of the accompanying hyperemia, may show a definite, though rarely very striking, increase in its total bulk.

During menstruation, the *retrogressive corpus luteum* is still a conspicuous structure, especially in the early part of the period. Toward the end of the flow, however, it begins to diminish in size, although its yellowish hue is still readily distinguishable on or just beneath the surface of the ovary.

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CHAPTER IX

MENSTRUATION IN THE LIGHT OF THE NEWER KNOWLEDGE CONCERNING THE PHYSIOLOGY OF REPRODUCTION

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The history of our knowledge of the physiology of menstruation has been sketched in Chapter III of this section, so that we shall begin the discussion of its present status with the concept as to the sequence of events which was almost universally accepted until very recently. In the first place, there has been rather general agreement that ovulation is a necessary precursor of menstruation. The discharge of the ovum from the graafian follicle occurs in the intermenstrual period, probably most often at about the thirteenth or the fourteenth day of the cycle—subject of course to the individual variations inherent in all physiologic processes. As the ovum passes down the uterus, the mucous membrane prepares for its reception. This preparation, indeed, begins immediately after the preceding menstruation (postmenstrual phase), for there are gradual hypertrophic changes from this time up to the beginning of the next period. Toward the end of the period appear the marked secretory changes which characterize the premenstrual, secretory or pregravid phase, corresponding to the pseudopregnant phase in certain lower animals, where somewhat similar histologic changes occur.

In the meantime, the follicle from which the ovum was expelled metamorphoses into the corpus luteum, which increases in size and activity, and reaches maturity a few days before the next period. In other words, the mature corpus luteum and the pregravid endometrium develop synchronously. It is not strange, therefore, that these structures have been accepted as physiologically interrelated. This deduction, it may be stated parenthetically, has been fully justified, as evidenced by Corner and Allen's experiments with their *progestin*, and by Hisaw's experiments with his *corporin*, active principles of the corpus luteum. In the event of fertilization and implantation of the ovum, the pregravid endometrium undergoes still further development and the corpus luteum maintains its structural and functional integrity. Here again morphological correlation and physiologic cause and effect, as ascertained by experiment, agree; for the decidual reaction of Loeb has been fully demonstrated to depend on the internal secretion of the corpus luteum.

If, however, as usually happens, the egg is not fertilized, a different sequence ensues. The egg dies, the corpus luteum retrogresses, and the endometrium degenerates and is cast off in its upper layers, with resulting hemorrhage. In a word, menstruation takes place.

From this series of events it is readily seen that the ovum occupies an important place, much seeming to depend upon whether it lives or dies. Such considerations led Robert Meyer to postulate his well-known theory of the "primacy of the ovum." According to this view, the ovum after its

not to speak of ripe follicles or corpora lutea. These cases now number literally hundreds in the records of the Carnegie Monkey Colony at the Johns Hopkins Medical School in Baltimore.

Many of these cases were discovered by the application of a most effective method, namely that of rectal bimanual palpation, by means of which ovulatory and nonovulatory cycles can be differentiated with celerity and ease. The new method has, on a large mass of material, corroborated certain findings derived from some sixty or seventy laparotomies and autopsies, viz.: (1) That nonovulatory cycles characterize all females for an entire season, namely Summer, the nonbreeding season; (2) that in late Fall and early Spring, favorable, vigorous females may ovulate regularly each successive cycle, or a nonovulatory cycle may be intercalated between ovulatory cycles without rhyme or reason; (3) that the amount of bleeding and other external signs, such as reddening and blanching of the sex skin, are similar in the two types of cycles. Such observations, repeated so often and so well controlled, leave no doubt as to the occurrence of menstruation without ovulation in monkeys.

A certain difficulty arises when one tries to apply these results to the human problem. The contention of both Meyer (1924) and Schröder (1928) that the periodic bleeding without ovulation described above is not a genuine menstruation, is based upon their choice of definition of menstruation, namely: periodic bleeding, associated with extensive endometrial desquamation and *preceded by the building up of the endometrium which distinguishes the progestational phase of the ovulatory cycle.* Certainly those of us who have studied, at least histologically, many thousands of ovaries in correlation with the menstrual histories of patients, can entertain no doubt that ovulation usually occurs in the human cycle. The only possible questions are: (1) Whether we have come to take these positive observations so much as a matter of course that perhaps the occasional exception has been glossed over rather casually; and (2) whether certain pathologic forms of hemorrhage, which still retain a certain degree of periodicity, are not to be looked on as human analogues of menstruation without ovulation. In the light of such work as has been mentioned it would seem to behoove us to analyze our cases more thoroughly, and to concentrate especially on those which do not conform to the accepted type. Gynecological literature already contains references to cases of menstruation without ovulation, but for the most part the precise data desirable are lacking.

The injunction just expressed is all the more justified by the fact that the nonovulatory type of menstruation has much in common with the usual type, as for example, regularity, intensity of bleeding, and desquamation. The process is the same in these respects; the only difference is the *kind* of endometrium cast off. The question involved is too fundamental to be dismissed with the statement that man has outgrown the process characteristic of the lower monkeys. This may be true, but does not explain the essential nature of the process. This is rather to be sought in the factors common to the two types of bleeding.

Another phylogenetic point of view has been expressed by Novak (1927, 1930), namely, that the functional uterine bleeding, observed so characteristically at puberty and the menopause, is to be looked upon as a reversion to the follicle type of sex cycle seen in most of the lower animals, including

controls. This striking increase in size is due to the increased number rather than the increased size of the follicles and corpora lutea.

The large number of maturing follicles and corpora observed, moreover, are of normal appearance, and ovulation is enormously accelerated. This is indicated by the large number of normal ova recoverable from the tube, if autopsy is done after ovulation. In one mouse, for example, forty-eight ova were found in one tube alone, while in a large number of normal mice the greatest number in one tube was seven. The normality of these ova is indicated by their capacity for fertilization, with the production of normal embryos (superpregnancy), as reported in a subsequent paper by Engle. To this astonishing acceleration of ovulation the authors have applied the term "superovulation."

The method of study employed by Zondek and Aschheim is the same in principle as that of Smith and Engle, though there are several not unimportant differences in technic which may explain some differences in results. The German investigators utilize only a single anterior pituitary implantation, and they employ weight rather than age as a criterion of immaturity in the experimental animals, probably a less reliable method. They, like Smith and Engle, noted typical oestrous phenomena in the uterus and vagina after their method of transplantation in immature animals, although the ovarian changes observed were somewhat different. There is usually, though not invariably, considerable enlargement of the ovary, with marked hyperemia, so that at times hemorrhage occurs into the follicular cavities, explaining the tiny hemorrhagic spots seen on the surface (blutpunkte). The follicles may undergo rapid maturation with discharge of the ova, but more often they remain unruptured, with luteinization of the granulosa cells and imprisonment of the eggs. The more moderate degree of the changes obtained by the method of Zondek and Aschheim is probably to be explained, as Smith and Engle suggest, chiefly by the different technic employed, and especially by the fact that only one transplantation is done. By either technic, the same general type of change is noted when mature animals are employed.

An important practical application of this new knowledge is the Aschheim-Zondek test for early pregnancy, in which the mouse is used as the test object; likewise the rabbit ovulation test developed by Friedman. Since these tests are discussed in another chapter reference to them must suffice at this point.

There are many other interesting angles of this epoch-making work and problems arising from attempts to analyze the different effects produced, as well as to separate the hormone or hormones in pure if not crystalline form. The papers of Evans and his associates should be consulted, for to them many advanced theoretical ideas are due. It is their opinion that the growth hormone is a distinct entity, that the follicle-stimulating and the luteinizing hormone are one and the same, and that the prolan from urine when added to the growth hormone changes this to the ovary-stimulating hormone. American workers generally, in contrast to most foreign investigators, are inclined to the view of the unity of the two principles, and no American biological supply house at this date has claimed the separation of prolan A and prolan B factors.

A point of vital importance in these studies is the fact that, if the test animals are previously castrated, no direct effect on the uterus or vagina

luteum principle, of very different and in some respects antagonistic nature, was assumed but not demonstrated. The feeling that such a principle must exist, however, was based on good grounds. We need only mention Loeb's pioneer work, which established the ovulation-inhibiting function of the corpus luteum and its special function of sensitizing the uterine mucosa, so that appropriate mechanical irritation, as well as the implantation of the egg, can bring about the production of placentomas. Together with this there was a mass of evidence, circumstantial but impressive, to be derived from the study of the histologic interrelationships of the ovarian and uterine cycles in the lower animals as well as in human beings.

One reason for the delay in the discovery of the corpus luteum principle was the fact that many investigators, including especially many of the "follicle" enthusiasts, appeared to overlook the obvious fact that the tests for such a hormone must necessarily be different from those indicative of follicle activity. The repeated failure to produce definite oestrous response from various sorts of corpus luteum extracts was not surprising but, indeed, to be expected. Comparative histologic studies alone would indicate that the corpus luteum is probably important in the production of the premenstrual or progestational phase, beginning its activity where the follicle leaves off. In the human cycle, for example, the follicle is responsible for the early slow hypertrophic changes in the endometrium up to the beginning of the secretory phase. It is at this time that the follicle dominates the ovarian picture. The final topping-off of the endometrium which is designated as the premenstrual or pregravid phase is associated with the development and maturation of the corpus luteum in the ovary.

In human beings, as already pointed out, comparative studies indicate that the corpus luteum is important in the production of the progestational phase of the endometrium, beginning where the follicle leaves off. A similar conclusion was reached from a study of lactation, and the luteal phase of the mammary gland was also postulated. The need for checking physiologic inferences based on morphological findings is well illustrated by these two examples. Corpus luteum extract, following "priming" by folliculin, has recently been shown to produce the progestational changes in the endometrium (Corner and Allen, Hisaw); lactation, on the other hand, requires the stimulus of the anterior lobe after such folliculin and luteal "priming," as shown by Corner (1930) and by Nelson and Pfiffner (1931).

Corner and Allen's experiments, and those of Hisaw, deserve more than passing mention because they are so closely related to the subject of this chapter. Their success in producing an active extract of corpus luteum and the establishment of its potency by appropriate test objects mark important advances. The inhibition-of-ovulation test used by Papanicalaou (1926) and by Macht, Stickel and Seckinger (1929) have proved to be less specific and definite. Hisaw's relaxing hormone (relaxin), which causes softening of the pelvic ligaments of the pregnant guinea-pig, seems to be distinct from the "progestin" of Corner and Allen or the "corporin" of Hisaw, which affect chiefly the endometrium.

Two test objects were selected by Corner: (1) The uterus of the castrated rabbit, and (2) the rabbit castrated during pregnancy. In the former, full pseudopregnant proliferation, or proliferation even greater than normal, may be secured by injection of progestin. In the castrated monkey, Hisaw,

The statement that menstruation may take place without ovulation has been interpreted to imply that there is no follicular activity. The present authors have themselves been guilty of aiding and abetting such a statement, but now consider this an error. When it is reported that "no follicle was visible in the ovary" that may well hold for the gross appearance, but on sectioning the gland, numerous growing follicles, up to 0.5 mm. in diameter, may be found imbedded between the cortex and the medulla. There is ample reason to believe that such follicles are not without their influence upon the menstrual phenomena.

It is interesting to follow the changes in the ovaries and uterus in monkeys by rectal palpation. There is every gradation from a small but succulent elliptical ovary to one nearly or quite spherical, and of the size of a medium or large garden pea. The latter usually contains a graafian follicle capable of ovulating, and the collapse of the follicle can readily be detected by subsequent palpation. Other animals whose ovaries harbor only small or medium follicles may show much sex color and menstruate regularly and freely; yet there is no ovulation, no pregravid endometrium. An amenorrheic animal may in successive cycles show "staircase" increase from cycle to cycle (Hartman, 1932) but only after three, four, five or more months reach the climax and ovulate. The threshold for bleeding, from the standpoint of follicle size, and also from that of substitution therapy, is extremely low as compared with the growth effect upon the uterus itself.

We may concede, then, that the follicle is an important factor in the cycle. Its growth and decline, and not the growth and decline of the corpus luteum, may possibly be the essential factor of the menstrual cycle. This concept is not new and has many facts in agreement with it, as will appear below. Even the current view which considers the growth and decline of the corpus luteum responsible for the menstrual flow is in a sense consonant with the notion that the female sex hormone is essential, for it has been shown (Frank and Gustafson, Pratt and Allen, and Allen, Pratt and Doisy) that the human and monkey corpus luteum contain the female sex hormone. Indeed, Frank has shown (1929, p. 188) that this hormone in the circulating blood of women reaches a high point and suddenly drops a day or two before menstruation sets in. The inference might be drawn that it is not the failure of luteal secretion (progestin) but the failure of the female sex hormone which is the essential factor. This notion would place the ovulatory and the nonovulatory menstrual cycle on a common ground.

Uterine bleeding may be brought about artificially; for example, by the removal of the ovaries. In women a bleeding almost invariably follows two or three days after castration, if this is performed in the latter half of the cycle. The same is true of the monkey (Hartman, 1932). In women it is less likely to follow castration earlier in the cycle; but in the monkey castration seems to result in bleeding regardless of the cycle. Thus von Wagenen (1932) records a second (induced) bleeding seven days after the regular flow where castration was done on the fourth day of the latter, but no second bleeding followed castration on the first day. This work (1932) also records a bleeding in the mangabey several days after complete transection of the spinal cord at the level of the tenth thoracic vertebra. It should be emphasized that in all these cases of artificially induced menstruation the phenomena are in every respect the same as in spontaneous nonovulatory cycles. The

changes which occur in the endometrium, more particularly in the blood vessels. Bartelmez has made a good beginning in this direction and Markee, under the direction of Bartelmez, using Schochet's method of transplantation of endometrium into the anterior chamber of the eye, promises to elucidate the cyclic changes in the behavior of the uterine blood vessels. The factors causing these changes will be found of significance to the problem in hand.

One other type of bleeding may be touched upon in passing: the so-called "intermenstrual bleeding." How does that fit into the picture? Our tentative explanation is that at about the time of ovulation there is a temporary hiatus in the secretion of folliculin. This may begin even before the rupture of the follicle; it continues for a day or two, until the corpus luteum has become sufficiently vascularized to function. Hartman (1932) has called attention to the temporary and evanescent increased firmness of the uterus at this time in the ovulatory cycles, as disclosed by rectal palpation, whereas an even, unbroken and progressive softening would be expected if the hormone production were continuous

Pathologic bleedings are even more obscure than the physiologic. They will be discussed in another place. Their study may be expected to throw some light upon the normal process; on the other hand the hope of therapeutic treatment of pathologic bleedings lies in the solution of the essential cause of menstruation.

SUMMARY

In the human menstrual cycle the corpus luteum occupies a prominent rôle. As noted above, its rise and decline synchronize so admirably with certain events of the cycle that it has been causally related, often without good evidence, to: (1) The pregravid changes in the endometrium; (2) the proliferation of the mammary gland and lactation; and (3) the inhibition of the menstrual flow. That this circumstantial evidence is unreliable is shown by the fact that, although corpus luteum extract has been found actually to produce the secretory phase of the endometrium, it is absolutely ineffective in relation to the mammary hypertrophy and secretion. Is there experimental evidence for the third alleged function of the corpus luteum which chiefly concerns us here, namely, the inhibition of bleeding?

That a positive answer should be given to this question would seem to be indicated by the fact that extirpation of the gland or removal of the ovary containing it results, after an interval of several days, in uterine bleeding. If, now, one inquires what hormone has been removed or withdrawn from the field of action by such extirpation experiment, one has to choose between folliculin and progestin (corporin). That it is the former rather than the latter is suggested by Hisaw's failure to stop the postoperative bleeding with corporin, and his success in inhibiting the bleeding indefinitely with theelin.

It would seem, therefore, that while folliculin is circulating in the blood, menstrual bleeding is inhibited. The assay of the human corpus luteum by Allen, Pratt, Newell and Bland, and Frank's assay of the blood for folliculin would both indicate that the production of folliculin does not end with ovulation. On the other hand, it is not easy to explain the progressively rising folliculin curve of Frank altogether by the amount of folliculin which Allen and his associates found in the corpus luteum.

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CHAPTER X

THE REPRODUCTIVE CYCLE IN ANIMALS

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Before Marshall first published his handbook on "The Physiology of Reproduction," in 1910, the literature on this subject was scattered throughout works on natural history, anatomy, and physiology. In gathering together this information the foremost English student of the subject performed a most useful service both for the general biologist and for the specialist in the field. The material added in Professor Marshall's second edition (1922) betokens the increased activity in sex studies during the intervening decade. Although it must be conceded that the decade since 1922 has marked the greatest advance in sexual physiology, the handbook still serves as a mine of references and affords the student a most useful initial guide to wider reading.

The impetus to the recent developments in the field of reproduction was the discovery of a new rapid method of studying the reproductive cycle of mammals, namely, that of Stockard and Papanicolaou (1917), who showed that a simple microscopical examination of the cell content of the vagina of the guinea-pig affords a certain index to the cyclic activity of the genital organs. Utilizing this so-called "smear method," Allen and Doisy in 1923 developed their castrated mouse test for the female sex hormone, by which assay of the active principle in various organs and body juices was made possible. Finally in 1926 Zondek and Aschheim (see book by Zondek) and Philip E. Smith demonstrated the relation of the anterior lobe of the hypophysis to the ovary—its function as the "motor" of the ovary.

With these three fundamental discoveries the endocrine aspects of reproduction received a tremendous impulse and the ensuing large output of experimental results reflect the vogue of endocrines in relation to reproduction. There are today few large biological laboratories that do not have one or more workers in the field. The results of the American work will be available in book form in the summer of 1932 (Sex and Internal Secretions, E. Allen, editor) and should constitute a source book of interest to the gynecologist and the biologist alike. That the newer knowledge has in it much for the specialist is shown by the revision of E. Novak's book, the works of R. Schroeder, W. P. Graves and R. T. Frank, as well as Keller's and Fraenkel's contributions to Halban and Seitz' Biologie und Pathologie des Weibes. Inasmuch as many old observations on reproduction in mammals are to be found in papers dealing with the early development of the mammalian egg, the reader who wishes to pursue the subject further will find such works listed in Hartman's paper (1929), "How Large is the Mammalian Egg?," which includes 173 titles.

THE BREEDING SEASON

It is a well-known fact that most animals have a season for mating and spawning or for mating, gestation, and caring for the young. The intensity

4. The anterior lobe of the hypophysis, either in the form of extract or tissue implant, is capable of stimulating the growth changes in ovum and follicle, whether in fishes, reptiles, amphibia or mammals.

5. The rupture of the follicle and extrusion of the egg also constitute processes ascribable to anterior hypophyseal stimulation both in the higher forms such as the rabbit (Friedman) or the rat (Smith and Engle), and in lower vertebrates such as the frog, the salamander (Adams, Noble), or the snake (Houssay).

6. A corpus luteum, though in simple form, is found in the lower vertebrates. It has not yet been determined, however, whether its removal affects the nurture of the fetuses, as, for example, in fishes or in lizards that have an intra-uterine gestation, or in birds, like pigeons and doves, that feed their young secretions from the hypertrophied mucosa of the crop. It is already established, however, that this "pigeon's milk," like the milk of mammals, is not secreted in the absence of anterior pituitary hormone.

7. The female sex hormone (theelin, folliculin, feminin, etc.) is found in the gonads of all vertebrates. That it is also found in plants does not militate against its indispensability in animals. It certainly has a peculiarly specific action on the female genital tract in all forms.

8. The female sex hormone conditions secondary sex characters of the female throughout the series. The hormone is now available in crystalline form and in the hands of Doisy, Butenandt, Merrian and Laqueur the crystals agree. With the aid of the hormone the action of the gonads may be exactly reproduced in castrated females. (See Merrian, Physiol. Rev., 1932, for the chemistry of the hormone; also E. Allen, Volume III of this work.)

9. The male sex hormone is also sex specific and has likewise been crystallized (Butenandt). It does for the male what the female sex hormone does for the female. It presides over the functioning of the accessory male glands as proved by the tests devised by Moore and co-workers (Gallacher) on the guinea-pig. It likewise conditions the male secondary sex characters, as, for example, the nuptial pads in frogs (Noble) or the plumage in birds (F. R. Lillie and co-workers).

These points suffice to show that the cyclic changes going on in the reproductive organs of the various species conform to a pattern and are physiologically dependent upon a very few hormones which appear to be identical throughout the Phylum Vertebrata as definitely as the backbone itself. This fact lends a feeling of dependability and general applicability to generalizations based on experiments on limited groups of animals.

The hormonal control not only involves the histologic changes in the sex organs but general somatic changes in the physiology of the vegetative organs and the central nervous system. A striking example is the rhythm of increase and decrease in the number of chromophil cells in the ganglion of the cervix uteri (Blotevogel and Poll). The literature on cyclic changes in metabolism or cyclic changes which take place under the influence of the female sex hormone is a very large one, especially as regards the human cycle (see E. Novak or R. Schroeder). A most remarkable phenomenon in this connection is the very precise cycle of spontaneous activity discovered in the rat by Wang (1924). At oestrus the female travels in the treadmill

follows almost exactly ten hours post coitum. This relation renders the rabbit ideal for many kinds of experiments.

At oestrus the vaginal content is characterized by large scalelike cells with nuclei or simple scales or cornified cells; small nucleated epithelial cells and leukocytes are typically absent. The uterus is succulent, vascular, often dilated with fluid; epithelial elements undergo proliferation by mitotic division of their cells. In the dog and the cow and perhaps other forms the uterine contents are tinged with blood that finds its way through the epithelium, which is apparently intact. The epithelial lining of both uterus and fallopian tube shows a high columnar epithelium. The mammary glands are often slightly though definitely proliferated.

Oestrus in the cycle of lower mammals corresponds to the midinterval of the primate cycle, since ovulation takes place at these times. They have three other conditions in common: (1) Uterine bleeding of the dog and the cow corresponds to the intermenstrual bleeding of monkeys and human females; (2) the midinterval is the period of heat in baboons and chimpanzees and is the time of increased desire in some women; (3) the vagina typically contains few or no leukocytes.

Pro-oestrum.—This is the period of the rapid growth of graafian follicles and general recovery from the preceding low ebb of activity, the di-oestrum (see below). Epithelial cells in the vagina give way to flat scales containing nuclei. Pro-oestrum passes gradually into oestrus.

Metoestrum.—If the egg is not fertilized the corpus luteum fails to function after a greater or lesser period of time. In the mouse and the rat, with a cycle of four to five days, it is doubtful if thecorpus luteum fun ctions at all. In the guinea-pig it is short lived. The metoestrum is characterized by collapse of the distended uterus, great leukocytosis of the vaginal wall, enormous sloughing off of the vaginal epithelium. In the guinea-pig blood is found in the uterine lumen.

Postoestrum.—This term is loosely and erroneously used to designate any period of time following oestrus. By priority it should signify the time interval between oestrus or copulation and ovulation, which is ten hours in the rabbit, a variable period (not well established) in the ferret or the cat, and erroneously supposed by Hill to be five days in the marsupial Dasyurus.

Di-oestrum.—The interval of recuperation of the "resting" organs, which are at this time at their lowest ebb. The organs are small and anemic. Even the component cells may be reduced in size, as the smooth muscle fibers of the uterus (Stieve) and those of the uterine tubes (Anapolsky). This is the longest phase of the cycle; it may indeed occupy several months, as in the dog. The vagina shows leukocytes and epithelial cells in small numbers.

Anoestrum.—This is the extended resting period of animals that have but one breeding season a year. The sex organs in such cases undergo profound atrophy, being reduced a thousand-fold in some instances. Anoestrum refers to this condition of the organs in the nonbreeding season.

Pseudopregnancy.—In some forms, as in the dog, ovulation, which is spontaneous, is followed by the development of active corpora lutea. The result is a prolongation of the cycle, for corpora lutea directly or indirectly inhibit the onset of a new cycle. The corpora lutea, furthermore, bring about a much more advanced condition of the endometrium, which becomes thicker,

Although it is clear from the foregoing that there are definite cyclic variations in the excised smooth musculature of the genital tract, this is even more apparent when the organs are studied in vivo in the unanesthetized animal. This has been accomplished first by direct observation of the organs through an abdominal window (v. Mikulicz-Radecki, Westman), or by means of an especially designed laparoscope (Westman, 1929). The results indicate that both tube and uterus as well as their mesenteries undergo greatest activity at oestrus, or, in the monkey, in the midinterval. After ovulation the organs rapidly pass into the state of relative sluggishness. The female sex hormone would thus seem to condition the state of highest activity, but only, as Reynolds discovered, in the absence of inhibitors.

That this reasoning is correct was proved by the second method of studying the uterus in vivo, the uterine fistula method of Reynolds (1930). By means of a delicate balloon inserted into the uterus through the cervix protruding at the fistula it is possible to make tracings of the uterine contractions for permanent record. Strong uterine contractions are recorded at oestrus; but the train of events that are set off by the act of copulation bring about an inhibition of the contractions which indeed begin to manifest themselves as early as six hours post coitum, *i. e.*, four hours before ovulation. Reynolds and W. M. Allen have shown that progestin (extract of active corpora lutea of the pig) brings about quiescence (personal communication). This result was to be expected a priori; for in the presence of active corpora lutea 1000 rat units of theelin are incapable of bringing about motility, whereas in the quiescent uterus of castration only five rat units suffice to restore the motility to a maximum.

A similar phenomenon was utilized by Knaus, namely, the refractoriness of the uterus of the rabbit (the rat and the guinea-pig act differently; Siegmund, 1931) to pituitrin in the presence of corpora lutea. The refractoriness is absolute; no amount of pituitrin being able to overcome it. The gynecologist will appreciate the importance of this observation inasmuch as Knaus has applied the method to determine the ovulation time in women. Ovulation is calculated three days back from the day on which the uterus becomes refractory to pituitrin. According to Knaus's studies, ovulation takes place, in the normal cycle of twenty-six to thirty-one days, between days nine and eighteen. This accords precisely with the writer's findings in the monkey ascertained by more exact methods (Hartman, 1932).

THE OESTROUS CYCLE IN THE VARIOUS ORDERS OF MAMMALS

Monotremata.—The *Echidna* or Australian anteater lays a single egg once a year which she incubates in a pouch on her abdomen. The *Ornithorhynchus*, or the duck-billed platypus, builds a crude nest in her burrow on the banks of a stream where she deposits and incubates two, rarely one or three, eggs (Semon, Burrell).

Marsupialia (Kangaroo, Opossum, etc.)—Certain phases of reproduction in the Australian *Dasyurus* have been described by Hill and by Hill and O'Donoghue, but of only the Virginia opossum is the cycle at all known; in fact the opossum is the only wild mammal in which more than a beginning has been made in study of the oestrous cycle or the rate of development (Hartman, 1932, 1928).

at any time, maintaining continuously a set of follicles for the purpose. That the same set of follicles remain in a state of rest or low level of activity continuously is not proved: the fact that the doe often refuses the buck for no apparent reason suggests rather that follicles undergo atrophy, to be succeeded by a new crop. The low ebb of sex response would fall in the interval. This is not proved, but is suggested to the prospective experimenter or the pathologist using the Friedman test.

In the rabbit the vaginal cycle is poorly indicated in the smear (Kunde and Proud). After ovulation, even in the absence of fertilization, active corpora lutea form and the uterus and the mammary glands undergo pseudo-pregnant hypertrophy, which lasts sixteen to nineteen days. The period of gestation is thirty-one to thirty-three days.

The reproduction of the rabbit is conveniently presented by Hammond in an excellent and comprehensive monograph (1925).

Rodentia (Rat, Mouse, Guinea-pig).—*Rat and Mouse.*—The rat and the mouse (Muridae) are very much the same in the manifestations of their reproductive processes. Their vaginal cycle is the most clear-cut of any laboratory mammal, hence they are especially adapted for large-scale studies in which many cycles of many individuals must be rapidly and accurately determined by the vaginal smear method.

The cycles run four to five days. Ovulation occurs toward the end of oestrus. Cyclic corpora lutea are inactive: hence the cycle is short and is confined to the follicular phase. Since the corpora, moreover, degenerate slowly, many dozens of them from numerous cycles may accumulate in the ovary. At oestrus the uteri are distended with fluid, which functions in the almost instant transport of spermatozoa (Hartman and Bell, 1930).

The "luteal phase" occurs in case pseudopregnancy ensues after ovulation upon stimulation of the cervix either in copulation or mechanically, as by means of a glass rod. Sexual maturity is indicated externally by the opening of the vagina. A vaginal plug, consisting of coagulated semen, often encased in a sheath of desquamated vaginal mucosa, gives evidence that copulation was accomplished and affords an excellent means of timing embryological material. Classic monographs are available on the oestrous cycle, that by Long and Evans (1922) on the rat, by E. Allen (1922) on the mouse.

Guinea-pig.—The female guinea-pig differs from both the rabbit and the Muridae in the details of the sex cycle. The cycle is sixteen to seventeen days in length, the period of gestation thrice that of the rat and the mouse, double that of the rabbit. The vagina is closed in the di-oestrum by means of a closure membrane, which disrupts in the pro-oestrum and is renewed after the metoestrum (Stockard and Papanicolaou, 1919). Ovulation occurs spontaneously soon after oestrus. The vaginal smear affords a reliable index of the ovarian cycle. Red blood cells, originating in the uterus, characterize the metoestrous degeneration in the guinea-pig. Pseudopregnancy is normally not manifested. Compared with those of marsupials, the mammary glands of the guinea-pig do not respond to the hormones of oestrus or early pregnancy—a refractoriness which is in correlation with the long period of gestation: for the chief growth does not take place until toward the end of gestation. Hartman and Olbers (1932) have described the cyclic changes which the cervix undergoes—a neglected part of the genital tract, though to the gynecologist of great importance.

Ovulation is stated by these authorities to occur some twenty-four hours after the first acceptance of the male, although ovulation does occur spontaneously. The time relation of ovulation to oestrus is not clear. That a long interval may occur between the successive rupture of follicles in any given case, as Whitney thinks, or that ova may live for some days before fertilization, as Evans and Cole suspected, are conclusions that rest on inadequate evidence. Successive laparotomies on the same animal will have to determine these points.

There are at most two cycles a year. The vaginal changes are typical—progressive thickening of the mucosa and cornification of the superficial layers during the pro-oestrum, cornified cells and a minimum of leukocytes during oestrum, then desquamation and leukocytosis during the metoestrum—all typical events. The vagina in anoestrum and in pregnancy is very thin like that of the immature animal.

The fallopian tube, according to Gerlinger, undergoes the usual cycle, with an accentuation of the secretory phase. Because of its inherent interest the uterus of the dog has been the subject of numerous thorough studies, notably by Marshall and Jolly, Keller, Gerlinger, and Evans and Cole. Pseudopregnancy is markedly developed in the dog both in duration and in the hypertrophy of the organs, because of the persistence of corpora lutea. Not only do the uterus and mammary gland enlarge greatly, but the bitch may continue pseudopregnant for the normal span of gestation, lactating and preparing a "nest" in the absence of fetuses, much as has been reported for marsupials. Such cases are rare, but the glandular hypertrophy of the endometrium at twenty days of pseudopregnancy is indistinguishable from the pregnant organ; after thirty days the metoestrous degeneration is normally in progress. Evans and Cole have seen no evidence of menstrual phenomena during this degenerative phase.

The ripe graafian follicle of the dog is folded like a young corpus luteum and the theca cells are hypertrophied (Bischoff, Evans and Cole). Unlike all other mammals, again, the first polar body is not given off in the ovary but the first maturation division awaits the stimulus of the copulating sperm in the fallopian tube (van der Stricht, Evans and Cole).

The Ungulates (Pig, Sheep, Cow).—*Pig.*—The oestrous cycle of the pig has become well known through the contributions of numerous workers, particularly Corner. This author's most notable contribution in this direction is his careful description of changes, both gross and microscopical, of the graafian follicle and the corpus luteum. With the aid of this study it is now possible for any investigator to determine approximately the stage of the cycle by an inspection of the fresh ovaries of slaughter house material.

The cycle length is the same as that of the cow and the sheep, namely twenty-one days, recurring regularly so long as pregnancy does not ensue. Ovulation occurs at the end of oestrus or shortly after (Heuser and Streeter). Ova remain in the fallopian tube three days, most of this time in the lower fifth, as determined by D. Anderson. Cyclic changes have been described in the pig vagina (Wilson, McKenzie). Aside from the fact that there is no well-defined cornification of the mucosa, the changes are the typical ones. The fallopian tube was thoroughly studied by Snyder, who emphasized the dual nature of the ciliated and the secretory cells. The changes described by Snyder he found to hold also for the human—the high columnar cells

not the important factor in intracranial birth trauma, nor is the most important item the few drops of blood which are frequently found. The most important fact is that these evidences are the best available criteria of brain injury. It is probably true that brain damage occurs in cases with no evidence of lacerations and hemorrhage, though this is difficult to prove. We do know that marked edema of the brain and tissues is frequently found, both with and without lacerations and hemorrhage. Increased intracranial pressure no doubt results from such an edema.

Second, head molding is not the only important factor, as intracranial damage results from cases where the labor has been short and violent, and not associated with head molding, such as is seen in prolonged labors.

Third, depression of the occipital bone produces tension on the dural septa and probably damage to the medulla and cerebellum. Such depression of the occipital bone is apt to occur in vertex presentations with a short anteroposterior diameter of the outlet, also with a rigid perineum, or where vigorous attempts are made to protect the perineum by pressing the head against the pubic arch. Depression of the occipital bone also takes place in breech deliveries, when the occiput is used as a fulcrum and pressed against the pubes for rotation of the after-coming head.

Fourth, it is probable that increased intracranial pressure with engorged vessels and resultant edema can occur from a pumplike kind of action, when the fetus is alternately compressed and relaxed in its longitudinal axis as the result of contractions and relaxations of the uterus.

Fifth, the atypical compressions of the head seen in asynclitism, asymmetrical pelves, breech extractions and operative deliveries are important factors in the production of intracranial injury.

Sixth, one must bear in mind that there is not always equalized pressure of the head. This is illustrated by the localized edema and trauma which occurs on the scalp. Such unequalized pressure, externally, probably has its counterpart within the skull, analogous to that seen in cephalhematoma externa and interna.

It is not always possible to determine the exact cause of fetal death for multiple lesions are often found. Holland found postmortem evidence of intracranial injury in 48 per cent of the fetuses examined.

One of the authors, in a series of slightly more than 1000 fetal autopsies at the University of Minnesota in cooperation with the Department of Pathology, found evidence of traumatic death in 41.8 per cent of the fetuses which were alive at the onset of labor. If one excludes the premature fetuses, birth trauma was the probable pathologic cause of death in 39 per cent and it was thought definitely to be the cause in 31 per cent.

Of approximately 300 cases showing evidence of intracranial birth trauma sufficient to be a cause of death, only the minority were so diagnosed and recorded clinically.

As an addendum to previous remarks regarding asphyxia neonatorum, it is interesting to observe that of 39 cases where the death was clinically assigned to asphyxia 22 were reclassified as deaths from birth trauma after notation of the findings at autopsy.

Other injuries are less frequently the cause of death. The most common, aside from those of the brain and cord, are injuries to the abdominal viscera, especially the liver. One occasionally finds evidence of contusion and hem-

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of 5.7 mm. (Politzer, 1931; Keibel, 1896). The principal tubules of the various segments do not appear simultaneously but are formed in successive groups, the cranial ones first, and then the caudal ones. Once the collecting duct and

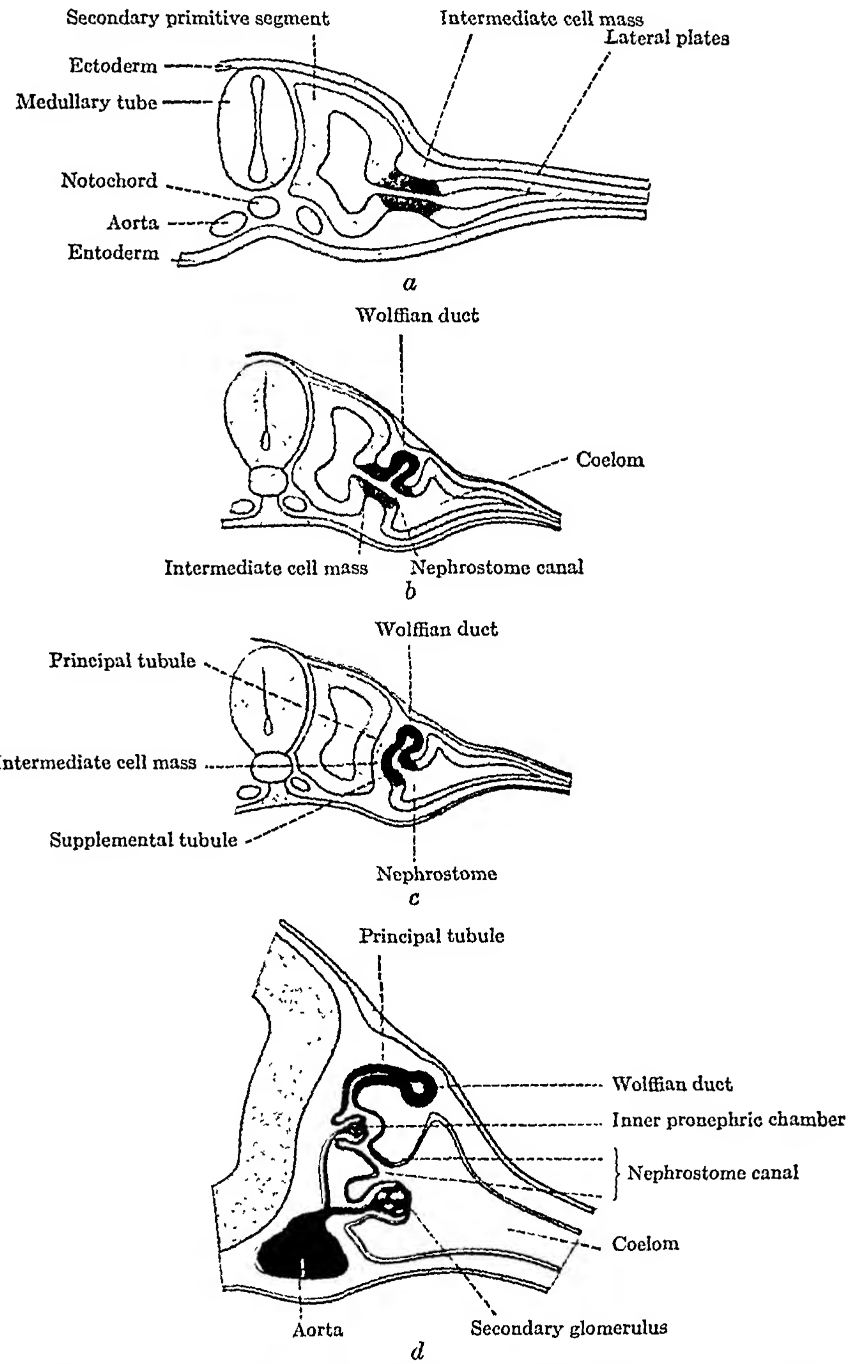

Fig. 260.—Diagram illustrating the development of a pronephric segment. (After Felix.)

principal tubules are formed, a further differentiation of the intermediate cell mass begins. In Fig. 260, *c*, the secondary primitive segment separates from the intermediate cell mass, which closes laterally and forms a connecting

pleasure from the act, so that each should respect the other's desires, and learn to adjust his or her tension to that of the other. Excess may readily lead to disgust and impotence in either partner. Sexual relations should be considered the fulfillment of a normal function of the body and should be regulated as such; regulated and moderated as are our desires for eating and drinking.

Too frequent intercourse may lessen the chances of pregnancy. Lloyd-Jones and Hays, working with rabbits, found that with excessive ejaculations the semen becomes less viscous, the spermatozoa less numerous and their motility somewhat reduced. The number of pregnancies in their experimental rabbits was reduced as the number of services of one buck increased.

The average number of spermatozoa in one ejaculation has been stated by Lode (whose work has been confirmed many times) to be around 226,000,000. The number may diminish to zero after a number of successive emissions, but increases again after an interval of a few days. The increase is gradual until about seven or eight days of abstinence, when the number may be as great as 551,000,000 per ejaculation. There is no increase in the number per ejaculation after this concentration has been reached, no matter how long the interval period.

Some cases of sterility may be explained by too frequent sexual union after the cessation of the menstrual flow. During menstruation most couples abstain from sexual intercourse, but as soon as the flow ceases, many couples resume coitus to excess. As a consequence, by the time the ovum is discharged from the ovary the semen may contain too few normal spermatozoa for the fertilization of the ovum.

Transportation of the Germ Cells.—The movements during sexual union, especially in the ventral position, and particularly those during the "epilogue" or "afterglow," are said by some to facilitate the transportation of spermatozoa through the generative tract of the female. The muscular contractions of the cervix and uterus have been credited with little importance in transporting the male germ cell through the vagina, the cervix and uterus to the uterine tubes, the important rôle being ascribed to their own locomotion. They travel at a rate of about 1 cm. every three minutes. On reaching the tube, where the ciliary current is opposed to their progress, it is stated by Van de Velde that the churning movements of the male on the abdomen of the female cause an alternate "sucking and blowing" action, muscular contractions and side-to-side movements of the tubes, thus aiding in the transportation of spermatozoa. This explanation, however, has little scientific basis. According to the recent work of Parker, the peristaltic movements of the tube itself result in the formation of compartments in the tube, setting up within the compartments currents which carry the spermatozoa toward the ovum. If this is correct the bodily movements probably have no part in aiding the transportation of the ovum. The driving motions of the male during orgasm, however, help in bringing the glans penis into close contact with the cervix, so that semen is deposited around the external os, thus giving the spermatozoa a good start on their journey to meet the ovum.

The ovum probably finds its way into the open end of the tube because of the directing action of the current produced in the peritoneal fluid by the

teenth. This view is now accepted by practically all investigators, and some, like Knaus, question the possibility of fertilization from coitus before or after the above limits. Two considerations should be borne in mind in this connection. First, it should be remembered that the above generalization is applicable only to women whose menstrual periods are quite regular, so that there would inevitably be much fallibility in either "conceptive" or contraceptive advice under any other conditions. This is a real disadvantage in view of the frequency of menstrual arrhythmia.

Secondly, there is still much uncertainty as to the duration of life of the spermatozoa after their entrance into the genital canal. In some animals, like the bat, they may survive for long periods, even months, but in the human the life span is believed to be quite short, probably only a few days at most, according to the current views of many investigators. If this is true, the period of fertility in the female, as indicated above, is correspondingly increased at each end, so to speak. The question is still a very controversial one, and the conclusions reached by a number of recent investigators have been anything but uniform. Certainly it would seem, almost from an *a priori standpoint, that the ten- or twelve-day period above indicated is* the optimum period for fertilization, and the weight of available evidence supports this view. Furthermore, a similar conclusion is reached by those who have studied the question in monkeys, in which the conditions are so similar to those existing in the human. On the other hand, there is reason to question the conclusions of Knaus and others that fertilization is strictly limited to a comparatively short span of ten or twelve days. This question, however, is more fully reviewed in Chapter XII.

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"Now each human egg, before it can develop, must be 'fertilized' by a male cell or spermatozoon. Male sex cells are tremendously smaller than the eggs: the 2,000,000,000 of them necessary to fertilize the eggs from which will come the next generation of mankind would easily go into an elliptical vessel the size of a capital letter 'O' in the text of this page.

"What a microcosm is such a fertilized egg, carrying as it does all the hereditary qualities from both parents that make the individual, into whom it develops what he is! It is an entity in size somewhere near half way between the electrons and 'corpuscles' of which matter is composed and the vastness of space known to the astronomer. Yet in the fertilized egg is bound up the capacity to develop into the complex mechanism of the human body; it has represented in it, perhaps by actual molecules capable of infinite and eternal multiplication, all the characters which the individual inherits from his parents, his grandparents, his ancestors back through the vistas of time, racial and familial—color of skin, hair, and eyes: stature and constitution;

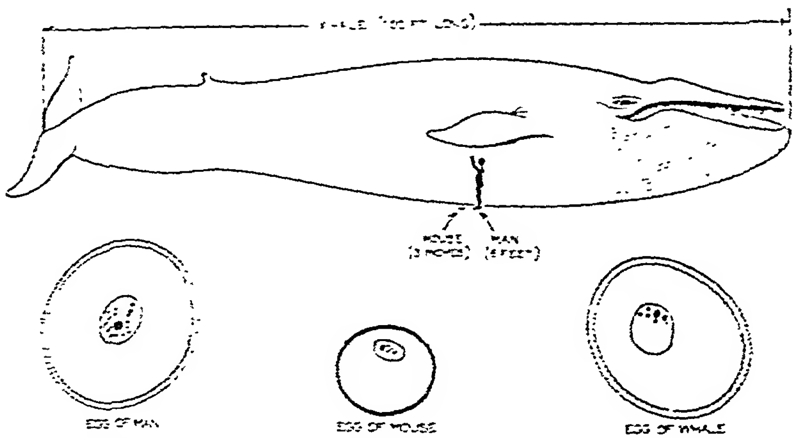

Fig. 153.—Diagram to illustrate the fact that the ovum of mouse, man, and whale are about the same size. In all mammals the ovum is dependent upon the body of the mother for sustenance. Courtesy Scientific American.

temperament and character. These myriads of factors are, moreover, represented, not in the whole egg but only in its tiny nucleus, which, in its turn, contains those self-perpetuating molecules, the genes, that determine at fertilization what each individual shall be.

"Truly the unfolding of an individual from the egg is the most marvelous phenomenon in Nature. The evolution of organic forms through eons of time pales beside what we can witness daily, superficially at least, in the development of the individual from the egg." (Scientific American, March, 1930.)

Continuity of the Germ Plasm.—The *germ cells* (sex cells or reproductive cells), which are the sperms or spermatozoa and the eggs or ova, are collectively known as *gametes*. In the process of fertilization, a male and a female gamete unite to form the *zygote*, from which a new individual develops. Germ plasm is the term applied to that line of successive cell generations that give rise to germ cells or gametes. The cells which take no direct part in the production of gametes and which cease to exist with the death of the individual

from their ancestors, thus hastening the evolutionary process. These experiments have almost universally met with failure. Alcohol, lead and other poisons have been tried. In some cases superior strains of rats or guinea-pigs resulted, but this was doubtless due to the killing off of inferior individuals, an effect long produced in domestic animals by selective breeding. It is only recently that real mutations were artificially secured, namely, by massive doses of x-rays, in the case of the fruit fly. The mutants thus produced "breed true," *i. e.*, the offspring exhibit the peculiarities induced in their parents when these were still in the gamete stage. Such cases may in a broad sense be classed as "inheritance of acquired characters" and constitute the only ones that may be considered proved. Heretofore no treatment of adult individuals even for many generations, as for example, circumcision, has in the slightest affected the race genetically.

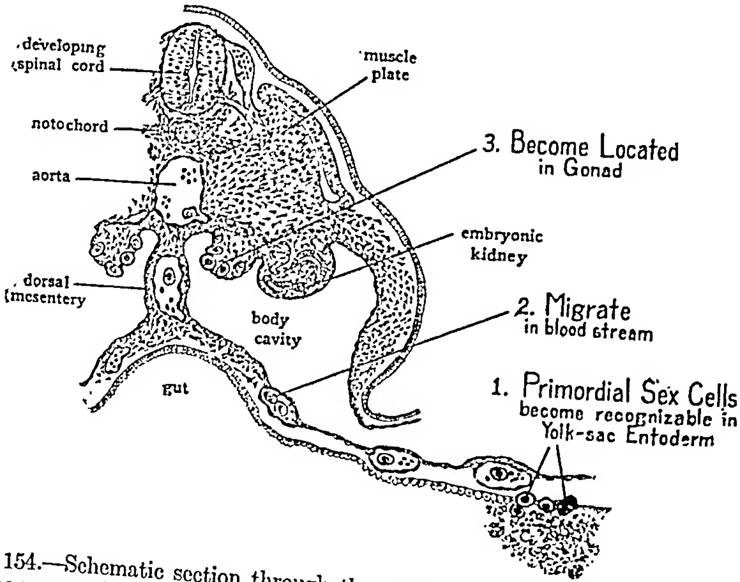

Fig. 154.—Schematic section through the midbody region of a young embryo illustrating the manner in which the primordial germ cells are believed to originate in the yolk-sac entoderm and migrate thence to the developing gonad. (From Patten, "Embryology of the Chick," published by P. Blakiston's Son & Co., Inc.)

A curious piece of folk-lore may be here mentioned because physicians doubtless frequently meet with it in their contacts with simple minds, namely, the belief that a former mate may influence the offspring of a subsequent mating. The fancied resemblance to the first husband of the later offspring by a second husband was explained as a "throw back." Needless to say that "telegony," as this fantastic belief is called, lacks every vestige of scientific proof.

Early History of the Primordial Sex Cells.—The sperms in the testis and the eggs in the ovary are easy to recognize. A study of these definitive gametes does not, however, give any clue as to their origin in the development of the individual. When did it first become possible to recognize the germ plasm as such? Can the ancestors of these elements be traced to very early stages or does the germ plasm, when we attempt to follow it back, lose

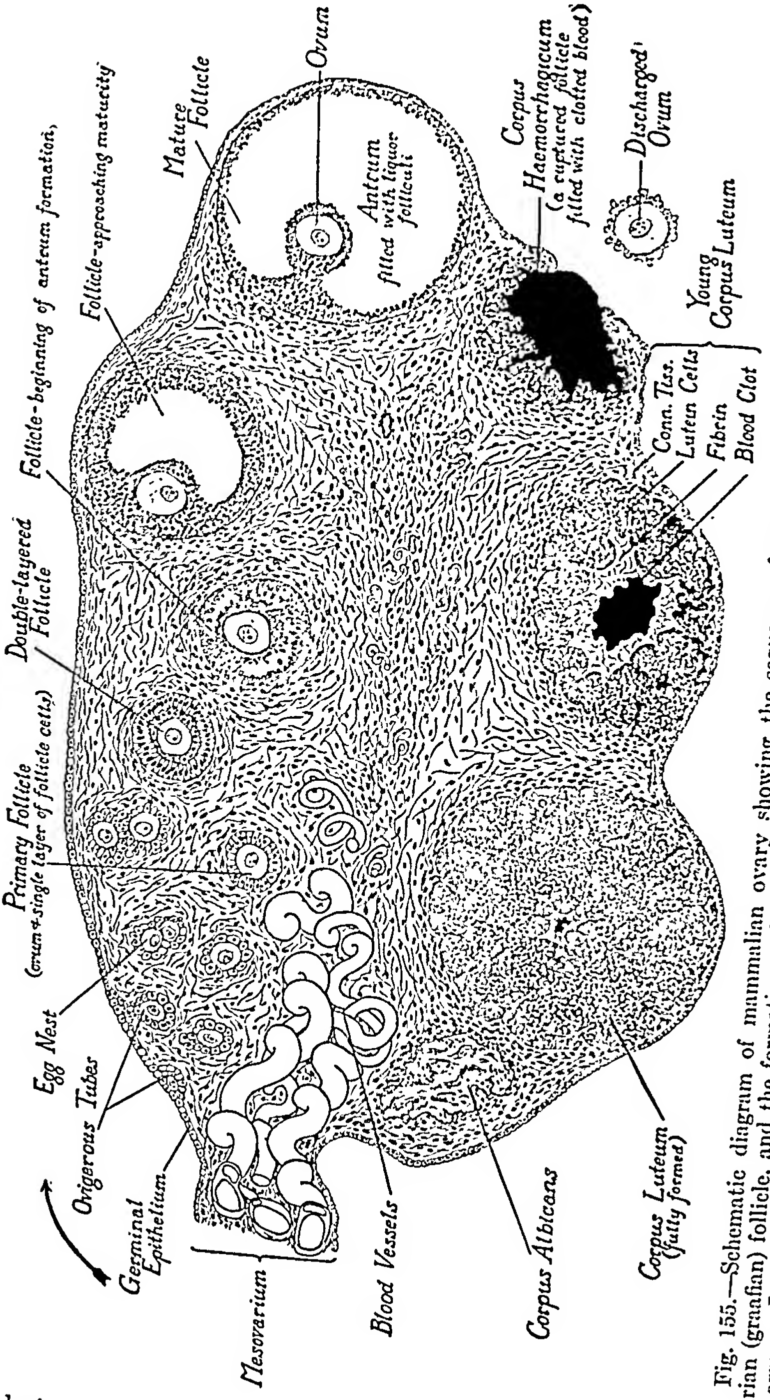

Fig. 155.—Schematic diagram of mammalian ovary showing the sequence of events in the origin, growth, and rupture of the ovarian (graafian) follicle, and the formation and retrogression of the corpus luteum. Immediately to the right of the arrow are shown two stages in oogenesis from the germinal epithelium. Follow clockwise around the ovary starting at the arrow. (From Patten, "Embryology of the Pig," published by P. Blakiston's Son & Co., Inc.)

more during her reproductive life from birth to the menopause. The over-production of gametes in the female would thus approach that already known for the male.

1. In mitotic cell division (Fig. 156, *A–C*) the chromosomes line up in the equatorial plane of the cell, split lengthwise with mathematical exactness, and each daughter chromosome passes to the daughter cell. Chromosomes and cytoplasm then both grow, as does no substance other than living, until they divide again. Not only is it true that every cell comes from a cell (*omnis cellula e cellula*, Virchow, 1858). but every chromosome comes from a previously existing chromosome.

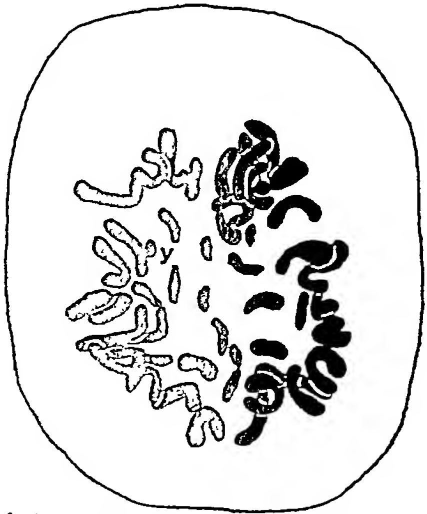

Fig. 157.—Equatorial plate of a spermatogonial division in the testis of a white man; 48 chromosomes are present including the small Y-chromosome which identifies a male cell. (From Painter.)

2. Each species has a distinct and characteristic number of chromosomes in the cells of the body. In *Ascaris megalocephala*, the round worm of the horse, the number is only four; by virtue of this simple condition this form has contributed much to our knowledge of chromosomes. Drosophila, the fruit fly, has but four pairs of chromosomes; and since these flies are easily reared by thousands, they have contributed extraordinarily to our knowledge of the mode of inheritance. The opossum has 22, a simple con-

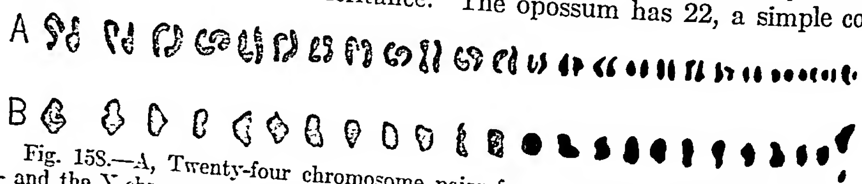

Fig. 158.—A, Twenty-four chromosome pairs from a human spermatogonium; the X- and the Y-chromosomes are at the end of the series. B, Twenty-three tetrads and the X-Y combination from the primary (reductional) spermatocytic division (Evans and Swezy).

dition for a mammal, which enabled Painter to discover the sex chromosomes of mammals and for the first time to make an accurate count of mammalian chromosomes. This led to his discovery of the sex chromosomes of man and the demonstration of the true number in man, namely, forty-eight, first stated as such several years before by H. M. Evans (Fig. 157 from Painter; Fig. 158 from Evans and Swezy).

broken up into chromosomes these chromosomes aggregated at once and without any evident scheme of arrangement at the equator of the spindle. In the prolonged prophase of a reduction division the members of the chromosomal pairs come to lie close to each other and so remain for some time. This pairing off of the chromosomes in the prophase is called synapsis. These synaptic pairs of chromosomes, still in intimate association, finally move to the equator of the spindle (Fig. 156, *D*). When in an ordinary mitosis splitting of the chromosomes would occur, in a reduction division the two members of the synaptic pair are separated from each other, one going bodily to either

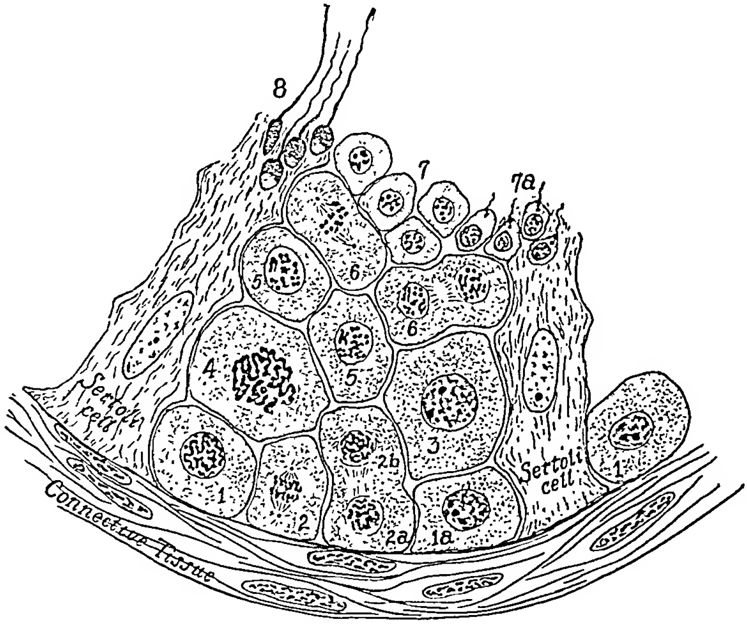

Fig. 159.—Semischematic figure showing small segment of the wall of an active seminiferous tubule. The sequence of events in the production of spermia is indicated by the numbers. A spermatogonium (1) goes into mitosis (2) producing two daughter cells (2*a* and 2*b*). One daughter cell (2*a*) may remain peripherally located as a new spermatogonium eventually coming to occupy such a position as 1*a*. The other daughter cell (2*b*) may grow into a primary spermatocyte (3) being crowded meanwhile nearer the lumen of the tubule. When fully grown the primary spermatocyte will go into mitosis again (4) and produce two secondary spermatocytes (5, 5). Each secondary spermatocyte at once divides again (6, 6) producing spermatids (7). The spermatids become embedded in the tip of a Sertoli cell (7*a*) there undergoing their metamorphosis and becoming spermia (8), which when mature are detached into the lumen of the seminiferous tubule. (From Patten, "Embryology of the Pig," published by P. Blakiston's Son & Co., Inc.)

pole of the spindle (Fig. 156, *E*, *F*). The resulting cells thus receive half the species number of chromosomes, and this half complement (*haploid number*) is made up of one member of each of the pairs characteristically present in the species (*diploid number*). Moreover, the cells formed in the reduction division contain different hereditary potentialities because they contain different chromosomes, not halves of the same chromosomes such as result in an ordinary mitosis. What hereditary possibilities are discarded into the polar bodies thrown off from the female gamete and what retained in the mature ovum is a matter of chance distribution. What potentialities find their

with the female gamete. As will be noted in greater detail below, the multiplication of egg cells precedes by a considerable period of time the maturation divisions. In a section of a typical mammalian ovary there are to be seen numerous, even thousands, of primordial ova (*oocytes*), situated in the cortical layer just under the connective tissue sheath or albuginea. These

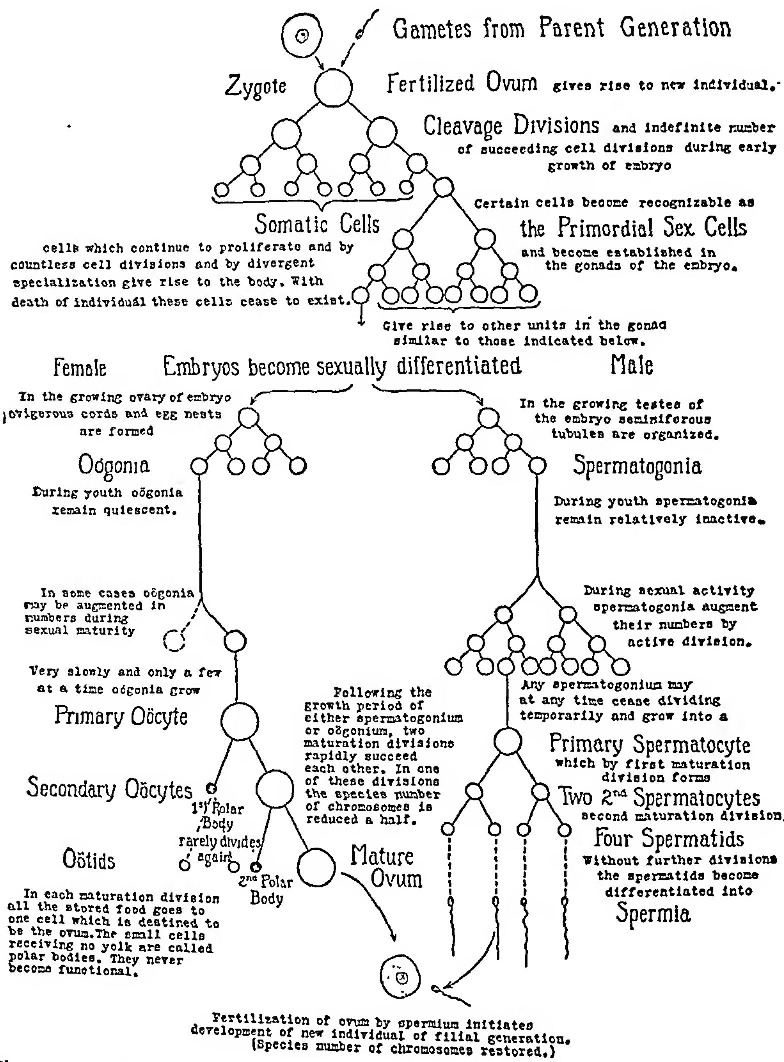

Fig. 161.—Chart outlining, for one generation, the history of the gametes and the germ plasm from which they are derived. (From Patten, "Embryology of the Pig," published by P. Blakiston's Son & Co., Inc.)

ova are approximately 15μ in diameter. Periodically some of them begin growing together with their satellites, the follicle cells, which multiply rapidly by mitosis. Soon a cavity appears in the follicle, by which time the ovum has attained about its maximum size (150+μ in the human). As ovulation time approaches, the antrum or follicular cavity in one of the follicles of the human ovary grows more than the others, the ovum gives off a polar body,

160). In this the chromosomes of the maturation spindle (presumably the first) may be seen. That the first polar body is given off in the human ovary, as is the case in all other mammals thus far studied except the dog (*cf.* Fig. 162) would seem to be further indicated by the tubal ova discovered by Allen, Pratt, Newell, and Bland.

The fundamental similarity between the maturation of the egg and of the sperm, together with the slight differences that exist, is shown in Fig. 161 and 162. That three ootids (*polar bodies*) are "discards" and are cast off, whereas all spermatocytes of the *second order* give rise to potentially functional sperms, is a matter of minor importance both physiologically and genetically.

Sex Determination.—Probably no embryological question has been the subject of so much conjecture as sex determination. From time immemorial theory after theory has been advanced to explain why this embryo became a male, that a female. The fate of most of these theories, estimated by one historian at 369, makes one exceedingly cautious in expressing even a tentative hypothesis. The chromosome theory is now the overshadowing one; and any person who would consider himself well informed biologically must know what it is, regardless of its ultimate fate. There are those who would say that this theory is the last word on the subject; but the fact is only this, that the correlation of sex chromosomes with the normal development of sex is undoubted; but how chromosomes bring about their effects is not known.

The behavior of the chromosomes in human spermatogenesis is much more completely known than it is in the maturation of the ovum. The full or diploid number, as seen in multiplying cells such as spermatogonia, is 48. It is important to note that in the human, as discovered by Painter, the sex chromosomes in the male are of two kinds, termed X and Y. So the male chromosomal number of 48 may be analyzed into 46 somatic chromosomes plus an X-chromosome plus a Y-chromosome. In the reduction division the X-chromosome accompanies 23 somatic chromosomes passing to one spermatocyte, the Y-chromosome migrates with the remaining 23 somatic chromosomes to the other spermatocyte. Two kinds of sperms result from these: 50 per cent contain 23 chromosomes plus X-chromosome, 50 per cent contain 23 chromosomes plus Y-chromosome.

Now all eggs are alike as regards the sex chromosomes containing 23 plus X, for the female cells have as a diploid number 46 plus 2X instead of 46 plus X plus Y as in the male. It is readily seen that the female chromosomal pattern will result from the union of a sperm containing X with the X-containing egg, and that a male chromosomal pattern will result from the combination of 23 plus Y in the sperm with 23 plus X of the egg. Since it is almost entirely a matter of chance which kind of sperm, female-producing or male-producing, unites with the ovum, it is clear that males and females must be produced in approximately equal numbers. It also follows that sex is fortuitous and is at present beyond control.

If one simplify the situation by using as an example the germ cell of an animal having but 8 chromosomes the chromosome theory of sex determination may be illustrated by the diagram shown in Fig. 163.

Ovulation and the Transport of the Egg.—The liberation of the ovum and its passage through the tube is discussed more fully in another section. The reader should, however, be reminded at this point that a mechanism

by virtue of their flagellate, vibratile tails. Moreover, the rate of progression of 3 mm. per minute is sufficiently rapid for them to reach the tube in ample time to fertilize the ovum. Cilia in the tube bring about a downward current; but according to some authorities the sperms are supposed to orient themselves to this current and swim against it.

There are, however, many facts which do not fit into this simple theory of sperm transport and more and more observations are accumulating that point to the active participation of the muscular wall of the female genital tract in the process. The factors involved are, moreover, probably different for each segment of the tract, namely, the cervix, the uterus, and the tube.

The physiology of the cervix is little understood. In the rabbit and in the rat it is known that if the female is disturbed a few seconds after ejaculation, no sperms are found in the cervix; but if she is left to react normally, within say five or ten minutes after ejaculation, the sperms in the rabbit are much farther advanced than is to be accounted for by their independent motility and in the rat the sperms have migrated *en masse* throughout the entire uterus.

While the factors involved in the progress of sperm through the cervix and uterus of various species of mammals and man are extremely problematical, Parker's explanation of sperm transport in the tube, based on observations in the rabbit, is the most reasonable yet offered, inasmuch as it takes into account a probable function of the tubal folds. These folds form pockets or compartments as they approach each other. In each compartment there are ciliary currents and counter currents forming eddies in which the sperms are tumbled about in all directions. With the contraction of the tube the compartments are continuously changing, being made, obliterated and remade. The general effect is the gradual advance of sperms up the tube. The gradual thinning out of the numbers of sperms as they advance up the tube is quite in accord with this explanation. Inasmuch as this topic is discussed in another section of this book it will not be pursued here. Reference may also be made to a discussion of these problems by Hartman in "Sex and Internal Secretions," Edgar Allen, Ed., Williams and Wilkins, Baltimore. The chapter referred to contains a much more extensive bibliography of this special plan of the subject than has seemed justified in the more general treatment here accorded to the subject.

Viability of Egg.—Heape long ago called attention to the difference in susceptibility to injury between the fertilized and the unfertilized ovum of the rabbit. All controlled experimental evidence points to the fact that the mammalian ovum, once discharged from the ovary, is extremely short-lived. Thus the viability of the rabbit ovum is a matter of a few hours, as mating experiments have shown. The opossum ovum exhibits very evident signs of degeneration in twenty-four hours. All human tubal ova thus far discovered were very palpably degenerated (Allen, Pratt, Newell, and Bland, 1930; Lewis, 1931). The conclusion is inevitable that unless the spermatozoa arrive in the ampulla of the tube soon after the egg is discharged from the ovary, fertilization is no longer possible. The human egg does not, therefore, live from the time of ovulation to the onset of the following menstrual period, as was at one time supposed (*cf.* Hartman, *loc. cit.*).

Viability of Spermatozoa.—There have appeared from time to time in the gynecological literature reports of the recovery of motile sperms from the

membrane, abuts on the surface of the cloacal tubercle (Fig. 278). According to Keibel (1896), the genital tubercle appears at 3 mm. At 8 mm. (Spaulding, 1921) the urethral groove appears on the anal slope of this eminence. This anal aspect of the genital tubercle is the urogenital membrane, the urethral groove almost bisecting the latter (Fig 278). The anal pit develops caudal to the end of this groove. At this stage, therefore, the urethra and anus are mere longitudinal depressions in the genital tubercle, and both are imperforate and separated from each other by a transverse bar.

As growth proceeds the genital tubercle is transformed into a compressed, conical protuberance (Fig. 278). The lateral slopes form the "lateral buttresses" which, arising from the apex of the tubercle, have a decidedly caudal trend, so that they finally disappear basally opposite the caudal border of the tubercle. The apex of the tubercle becomes clearly marked off from the more proximal portion by a shallow circular depression (coronary sulcus) indicating it as the future glans and separating it from the basal shaft. The urethral

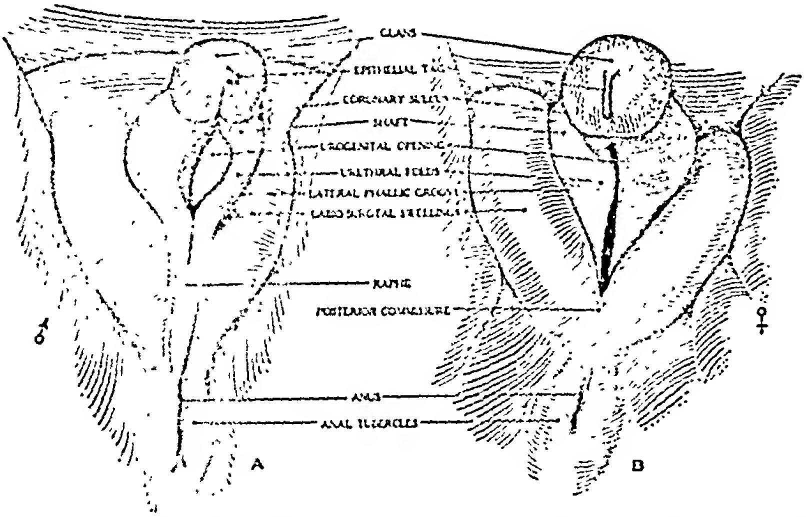

Fig. 279.—Drawings illustrating the parts of the external genitalia at the beginning of the definitive period. A, Male embryo 45 mm. long. B, Female 49 mm. (M. H. Spaulding, Contributions to Embryology, vol. 13.)

groove becomes a long lancet-shaped depression, broadest and deepest caudally, and narrowing cranially into a shallow slit limited by an epithelial tag just proximal to the primitive glans area. The urethral folds (margins of the groove) become elevated and merge cranially with the glans, and caudally broaden out to surround the anal pit as anal tubercles. Usually at this stage the urethral (urogenital) and anal membranes rupture. The perforation of the former transforms the shallow urethral groove into the urogenital openings, as a direct communication between the pars phallica of the urogenital sinus and the exterior. Spaulding observed that the urethral groove is shorter in the female than in the male, and that the glans area is more clearly indicated in the latter.

2. **The Phallus Period.**—At about 17 mm. the genital tubercle becomes elongated into a narrow conical organ which, because of its modified shape and its separation from the surrounding body areas by the newly formed labioscrotal swellings, is termed the "phallus," the "precursor of the penis

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The Indifferent Stage.—The indifferent reproductive gland appears within the urogenital folds along with the mesonephros, wolffian and müllerian ducts previously described. A small strip of the epithelium of the genital fold, derived from the coelomic epithelium medial to the mesonephros, forms the parent tissue of the reproductive gland. The epithelium of the urogenital fold usually consists of two layers of flat cells. In embryos of 5.3 to 7 mm.

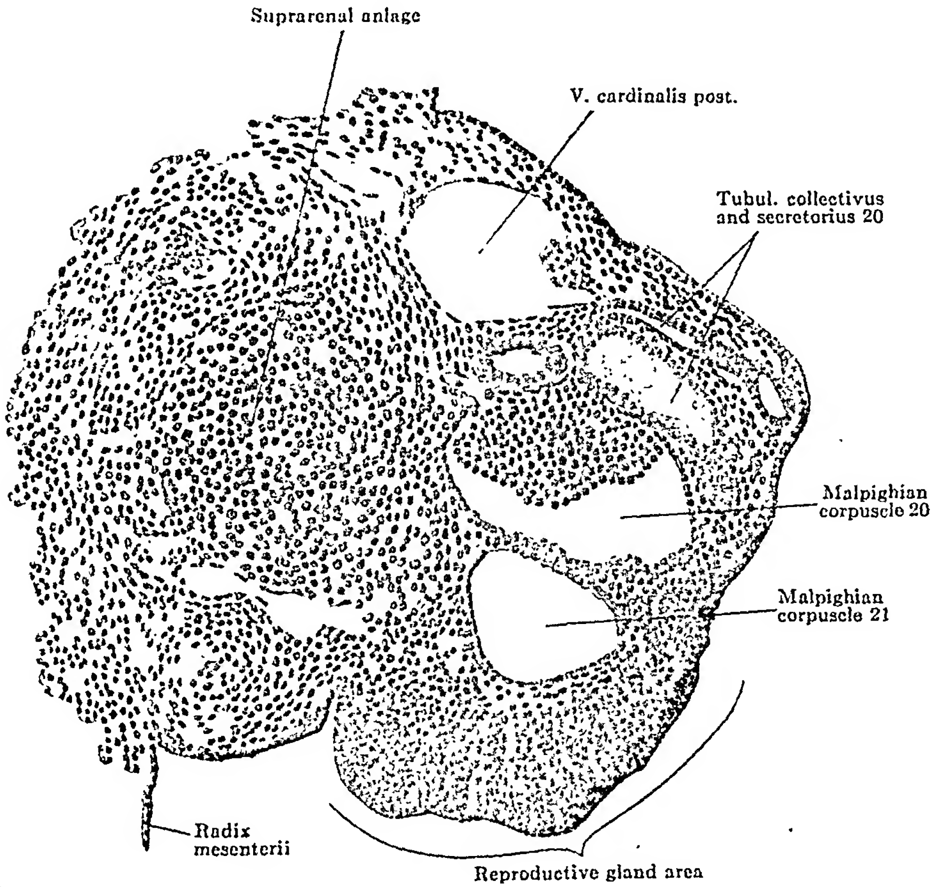

Fig. 281.—Transverse section of the urogenital fold of a human embryo of 11 mm. greatest length, 9 mm. head-foot length. (Embryo P. 1, from the collection of Professor Hochstetter, Vienna; × 150.) Almost all the parts of a mesonephric tubule are cut. Medial to the tubule is the suprarenal anlage; the mesonephric fold lies in the frontal plane, its summit is marked by the primary excretory or wolffian duct and a dorsolateral and a ventral surface may be distinguished. At about the middle of the ventral surface is the thickening of the peritoneal epithelium which forms the reproductive gland area. This consists solely of coelomic epithelial cells, which are becoming somewhat loosely arranged. No differentiation whatever of the epithelial mass is to be seen.

the coelomic or peritoneal epithelium on the medial surface of the urogenital fold and extending along its entire length becomes many layered, invades the mesenchyme of the latter, and eventually forms a solid mass of cells showing numerous mitotic figures. Soon lateral and medial grooves appear in the urogenital fold (Fig. 264, *c* and *d*), separating the reproductive gland from the mesonephros, wolffian, and müllerian ducts. However, the genital cells come into close contact with the malpighian corpuscles of the mesonephros at the

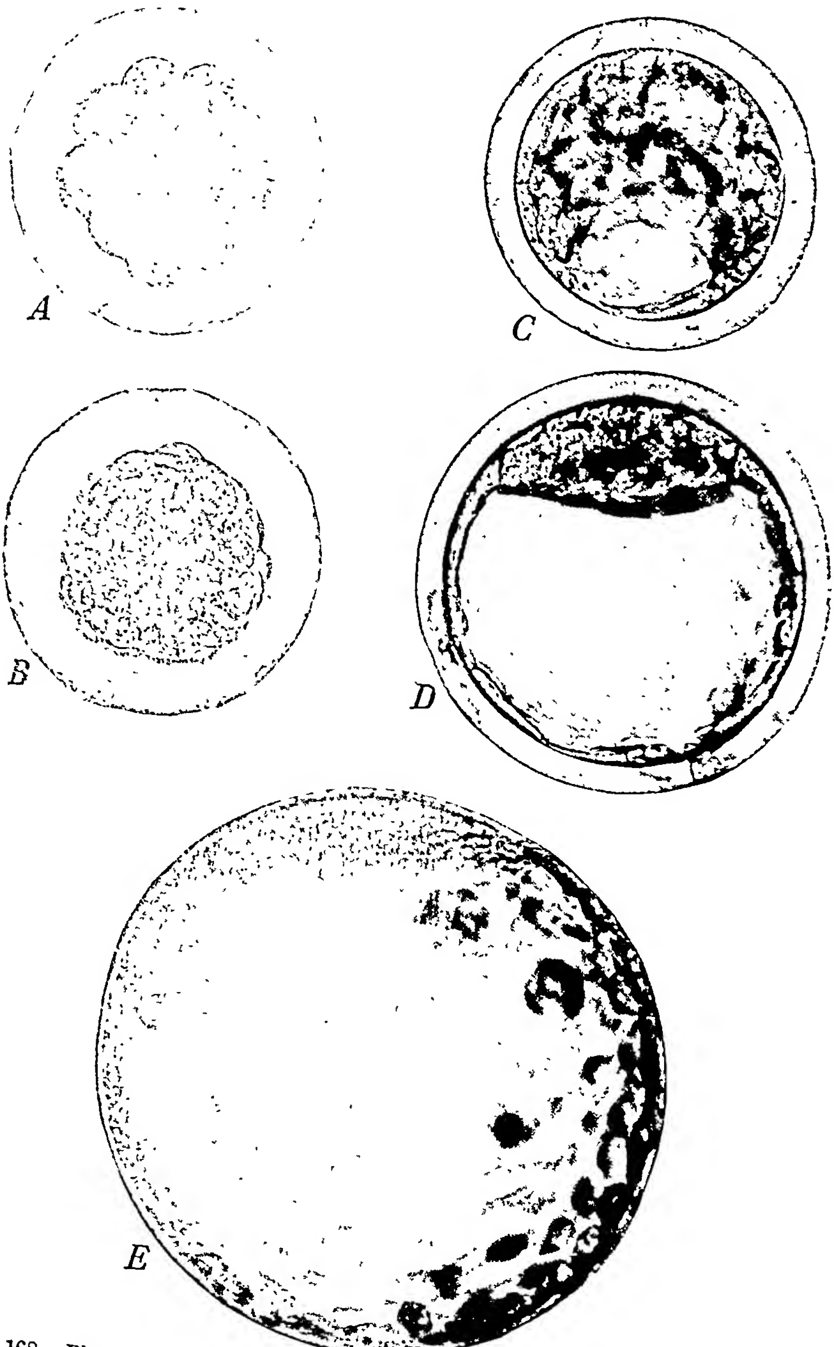

Fig. 168.—Photomicrographs (× 250) of living rabbit embryos in the morula and blastula stages. The temporary gelatinous layer shown outside the zona pellucida in Gregory's original photographs of the younger stages has been omitted in this figure. *A*, Morula, fifty-five hours after coitus. *B*, Beginning of transformation of morula to blastula by cell rearrangement with formation of central spaces, seventy-one and one-half hours. *C*, Central cavity more marked—peripheral cells flattened against zona pellucida, ninety hours. *D*, Characteristic blastula stage showing the rapid enlargement of the blastocele that immediately follows the disintegration of the zona pellucida, ninety-two hours. (After Gregory, Carnegie Cont. to Emb., 1930, vol. 21.)

space is retained and increased in size as more and more fluid accumulates within it, thereby expanding the outer layer of the blastocyst into a voluminous membrane which becomes a means of drawing food for the yolkless embryo from the uterine circulation of the mother. For this reason the layer of cells which constitutes the outer wall of the blastocyst is called the *trophoblast* or *trophectoderm* (Fig. 169).

In the formation of the distended blastodermic vesicle an internal cluster of cells is established at one pole. This, for want of a better term, has been called the *inner cell mass* (Fig. 169, A). Although it cannot be carried through in all details, the general distinction may be made that the inner cell mass is destined to be concerned primarily with the formation of the embryonic body, whereas the thin outer wall of the blastodermic vesicle contributes, not to the makeup of the embryo, but to the formation of protective and trophic membranes, which are developed into the fetal part of the placenta.

The stages of development thus far described are familiar to us almost entirely from nonhuman material. The reasons for the failure to secure human embryos in these very early stages are quite obvious. Fertilization normally takes place in the uterine (fallopian) tube near its fimbriated end. Assuming the process in man is similar to that in other mammals, the ovum takes three or four days to traverse the tube. The minuteness of the newly fertilized ovum makes its recovery from among the folds of the tubal lining exceedingly difficult. In animals excision of the tube followed by its irrigation and search for the egg in the washings under a binocular microscope may, however, lead to recovery of the ovum. Recently, human ova were recovered *in vivo* by a modification of this technic in which the tube was washed at the time of a laparotomy by means of a stream of sterile saline solution from a syringe inserted into the uterine lumen.

Still inferring from our knowledge of other mammals, especially the monkey, the growing ovum remains unattached for four or five days after it enters the uterus from the oviduct. Its recovery from the uterus during this time when it is completing the cleavage divisions and becoming transformed into a blastocyst presents the same difficulties as its recovery from the oviduct. In all probability it is nine or ten days after its fertilization before the human ovum becomes embedded in the uterine mucosa. In the monkey the ovum is just barely attached to the surface of the mucosa on the ninth day.

THE MILLER EMBRYO—YOUNGEST WELL-PRESERVED HUMAN EMBRYO

It must have been very shortly after its implantation occurred that the youngest known human embryo was secured. In the light of present knowledge of the reproductive processes a plausible history of the Miller ovum might be stated somewhat as follows. Ovulation probably occurred some twelve days after the first day of the last menstrual period. A fruitful coitus was nearly coincidental with ovulation, and within a few hours of coitus the actual meeting of the gametes in fertilization took place. On its three or four day journey through the fallopian tube the first half dozen cleavage divisions were carried out so the ovum was entering the morula stage on its arrival in the uterus. In the four or five days it remained free in the uterine cavity the hollowing out of the morula to become a blastodermic vesicle occurred and the trophoblast began to develop. About ten days after its

The three or four most cranially situated glomeruli and tubules become broken up and lose their connection with the wolffian duct, while those which are preserved maintain this connection. In the male the rete tubules grow into contact and fuse with the evaginations of the glomerular capsules which con-

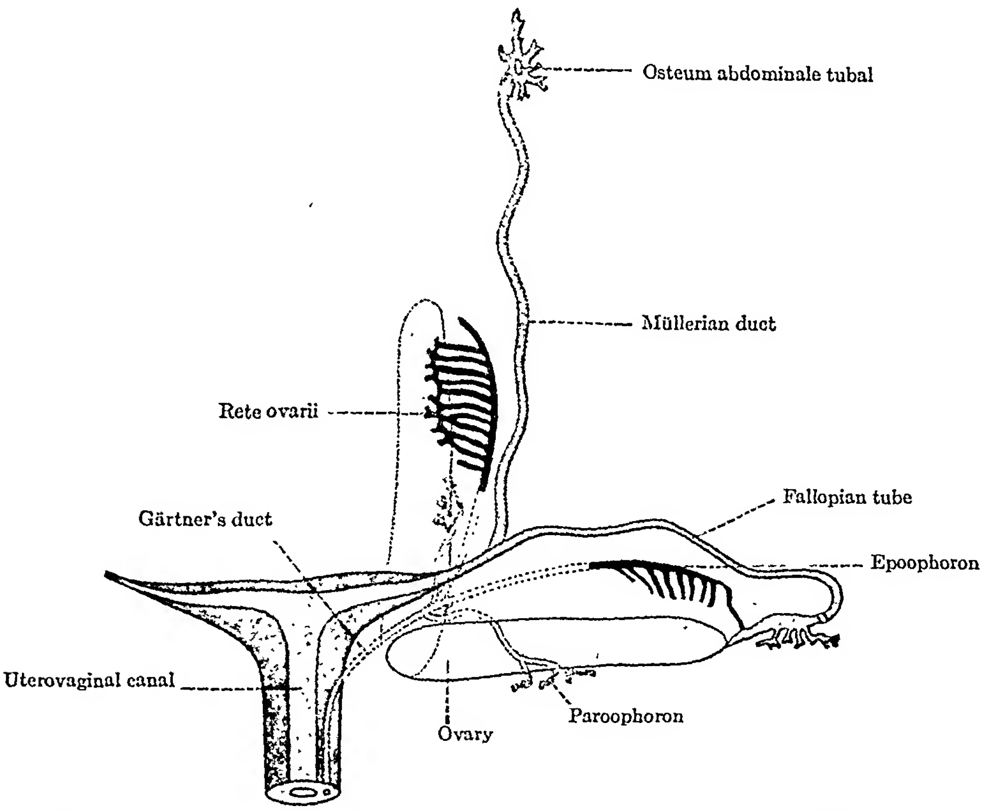

Fig. 287.—A diagram showing the relationship of the ovary to the müllerian duct, and mesonephros. The mesonephros and wolffian duct degenerate. Of the mesonephros the cranial portion persists to form the epoophoron, the caudal to form the paroophoron. Of the wolffian duct only that portion receiving the tubules of the epoophoron is retained, though portions of the rest may persist as Gärtner's duct. (After Fischel.)

nect the former with the wolffian duct (ductus deferens) (Fig. 286). In the female the union is not essential to provide an outlet for the products of the ovary, and the union is imperfect (Fig. 287).

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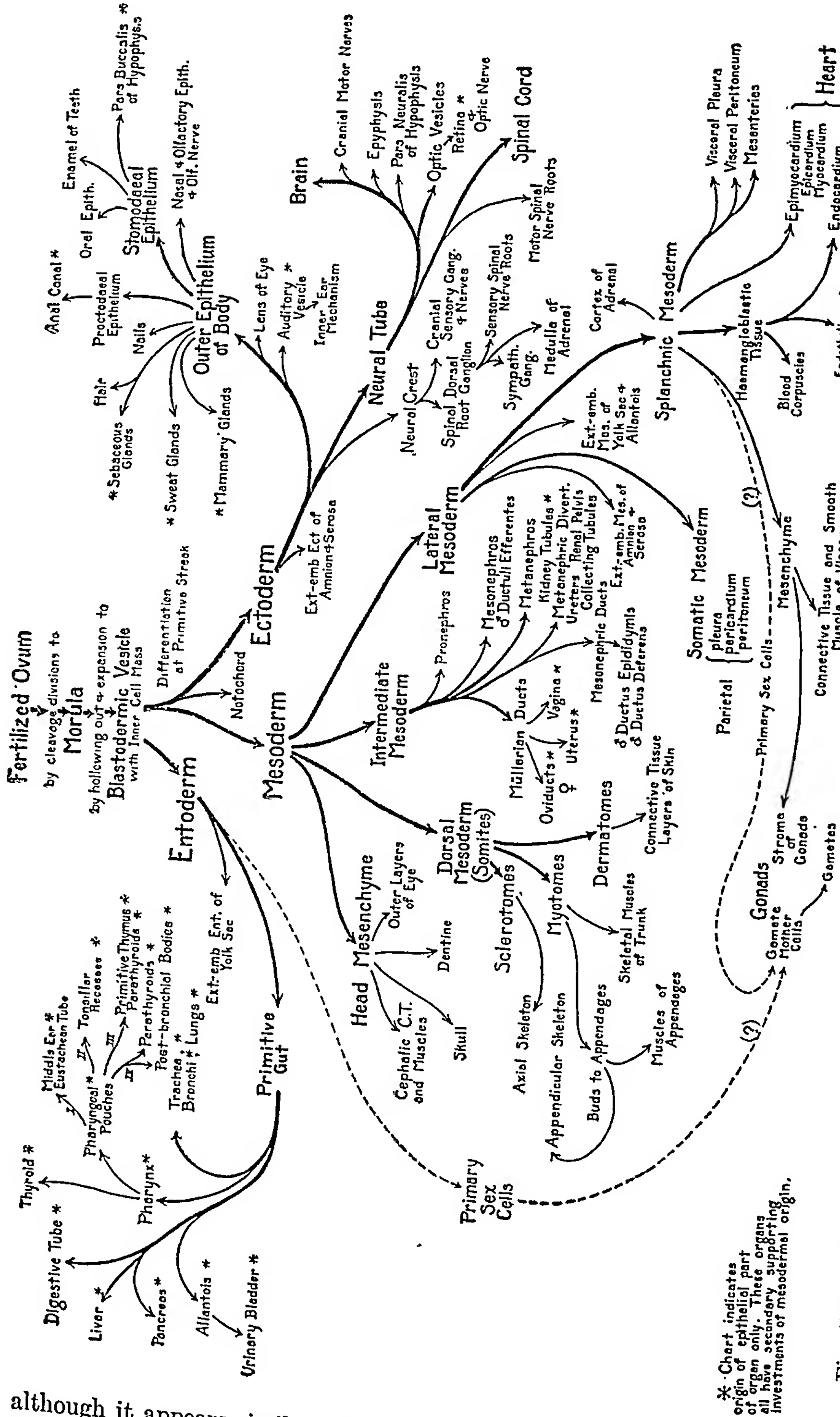

Fig. 172.—Chart showing the derivation of the various structures of the body by progressive differentiation and divergent specialization. Note especially how the origin of all the organs can be traced back to the three primary germ layers, ectoderm, entoderm, and mesoderm. (From Patten, "Embryology of the Pig," P. Blakiston's Son and Co.)

although it appears similar, will show no cells characteristic of the eye but will show different specific specializations. Experiments such as these indi-

region. In reality it is due rather to rapid growth from behind, which pushes the cephalic region ahead of it.

The fact that the growth of a young embryo is taking place chiefly from its caudal end has a bearing also on the relative progress of differentiation in different regions of the body. It is a striking fact that the cephalic end of an embryo will always be found precocious in differentiation as compared with the more caudal portion of the body. This much commented on condition seems but natural when we consider that the head is actually older in devel-

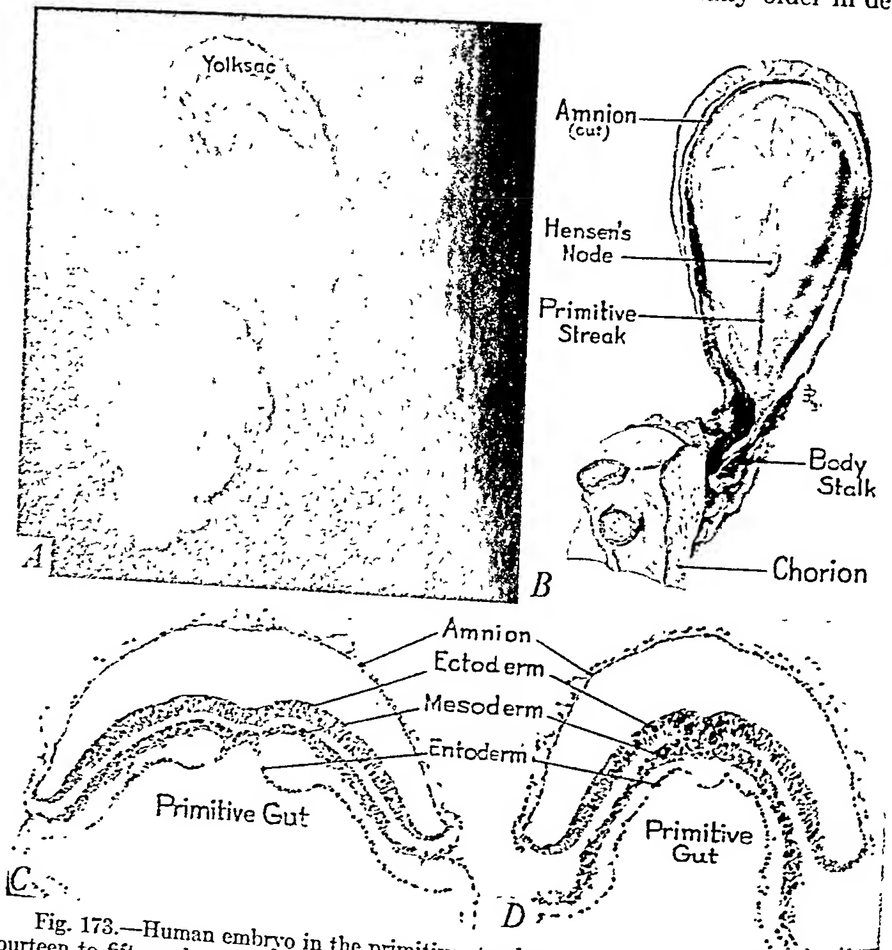

Fig. 173.—Human embryo in the primitive streak stage—probable fertilization age of fourteen to fifteen days. *A*, Photographed (× 18) before sectioning. *B*, Reconstructed from serial sections (× 25). *C*, Section through neural plate. *D*, Section through primitive streak. (After Heuser, Carnegie Cont. to Emb., 1932, vol. 23.)

opment. For the structures behind the head are laid down by cells which were proliferated from the growth center at the primitive streak, subsequently to the establishment of the head itself. Of course differentiation does occur exceedingly rapidly in the head. Were this not so other regions would pass it in developmental progress. But we cannot, in taking cognizance of this condition, afford to overlook the fact that the head is given a considerable lead at the outset by its earlier development.

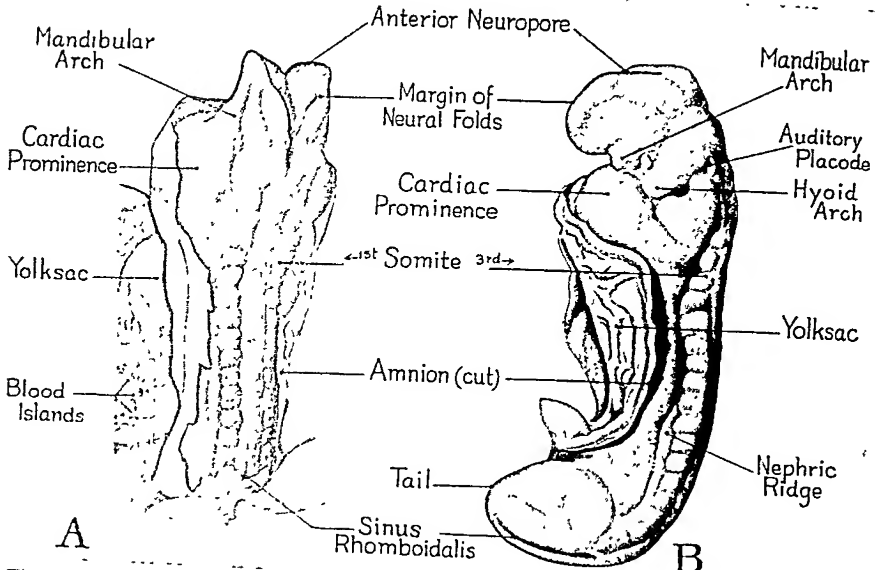

Fig. 175.—Human embryos of about three weeks' fertilization age. A, The Corner ten-somite embryo, probable age of about twenty days (× 25). B, The Heuser fourteen-somite embryo, probable age of about twenty-two days (× 30). (From Carnegie Cont. to Emb., 1929, vol. 20, and 1930, vol 22.)

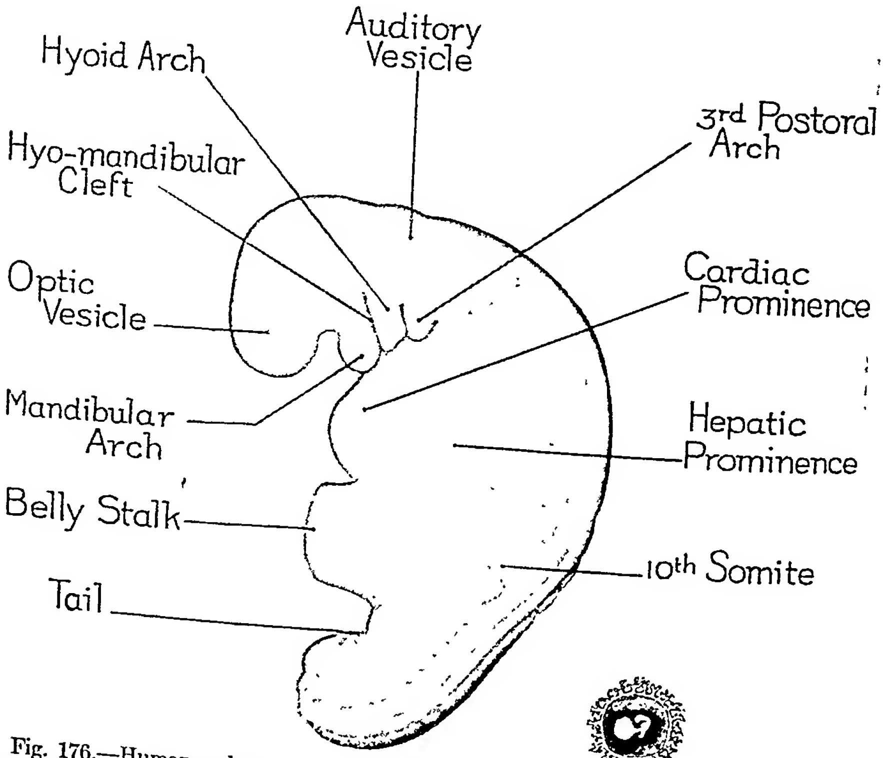

Fig. 176.—Human embryo of about four weeks' fertilization age. Retouched photograph (× 20) of embryo No. 6097 in the Carnegie collection; crown-rump length 3.6 mm; 25 pairs of somites. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

characteristic structures. Shortly after the primitive streak and the notochord have become clearly defined the ectoderm in the midbody region, cephalic to Hensen's node, becomes markedly thickened as compared with the rest of the superficial ectoderm. This thickening, known as the *neural plate*, almost immediately becomes folded into a longitudinal groove which

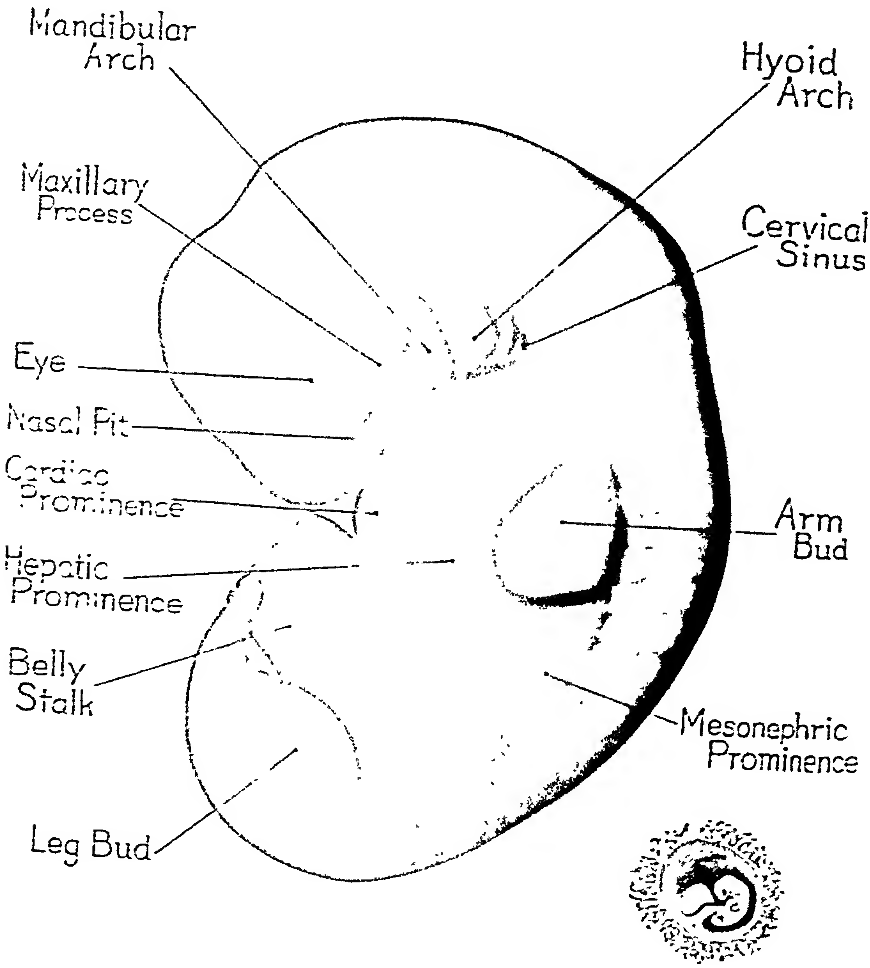

Fig. 178.—Human embryo of about five weeks' fertilization age. Retouched photograph (× 15) of embryo No. 6502 in the Carnegie collection; C. R., 6.5 mm. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

heralds the formation of the central nervous system (Fig. 174). With the establishment of the neural groove, landmarks begin to appear with rapidly increasing clearness. The neural folds in the anterior region are of much greater size than they are farther caudad. This condition foreshadows the differentiation of the neural tube into a conspicuously enlarged anterior portion, the brain, and a more attenuated posterior portion, the spinal cord.

176 and 177). Specializations of the superficial tissues about the optic vesicles soon make the developing eye readily identifiable (Figs. 178–180).

With the establishment of the brain, the ear, and the eye, there is no longer any difficulty in recognizing the general topography of the neurocranial

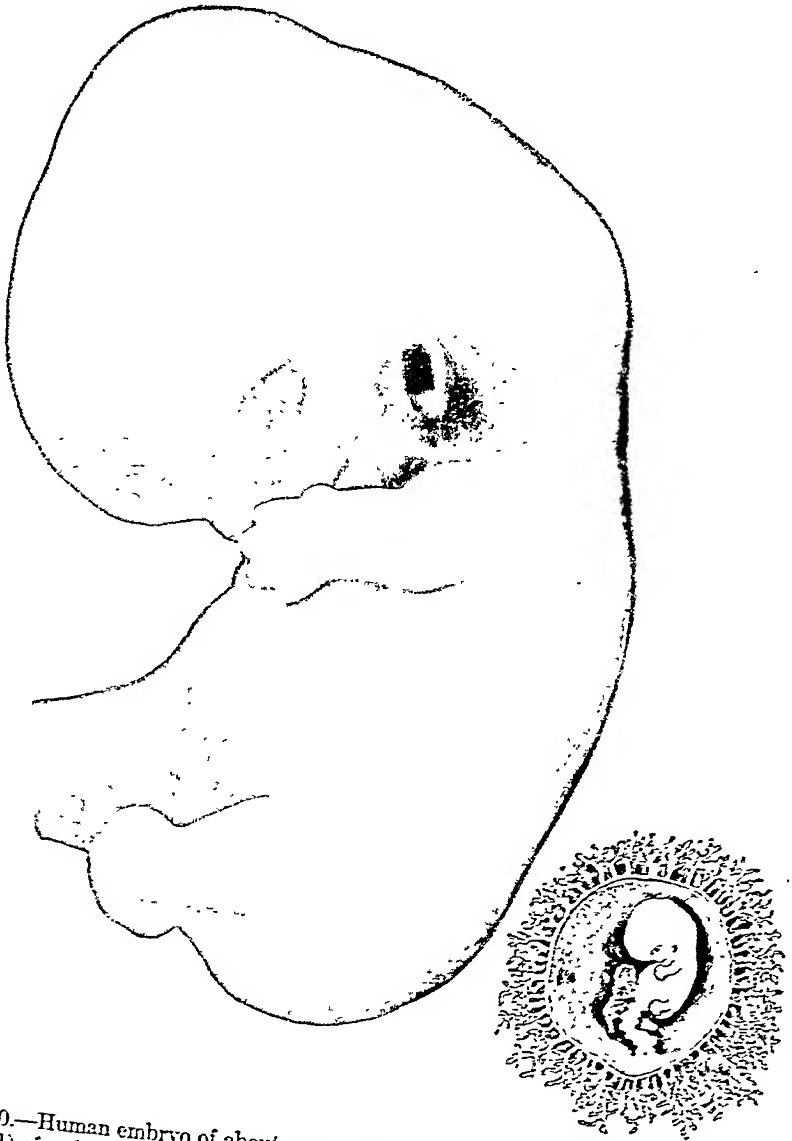

Fig. 180.—Human embryo of about seven weeks' fertilization age. Retouched photograph (× 7½) of embryo No. 1324 in the Carnegie collection; C. R., 17 mm. Sketch, lower right, shows actual size of embryo and its chorionic vesicle.

part of the head. Meanwhile the foundations of the visceral part of the head have been laid down. These primordial structures center about the stomodeal depression which is destined to be molded into the mouth. Cephalic to the

position in the anterior part of the trunk (Figs. 179 and 186). It is in this change in the position of the heart that we find the key to the curious course of the associated vagus and sympathetic nerves. These nerves acquire their connection with the heart when it is still near the segmental level of their origin (Figs. 184 and 185), and their fibers are pulled along with the heart in its migration caudad.

As early as the beginning of the fifth week a slight depression may be seen between the cardiac prominence and the prominence due to the growing liver. This groove indicates the position at which the diaphragm develops, and with its appearance we can differentiate the thoracic from the abdominal region of the trunk (Figs. 176–178).

Caudal to the hepatic prominence is the conspicuous *belly stalk*. Over this stalk the tissues of the embryo are continuous with the extra-embryonic membranes, and in it are embedded the large blood vessels by way of which the embryo receives its food and oxygen supply from the uterus of the mother.

It is also during the fifth week of development that the *appendage buds* make their appearance. The arm buds are formed adjacent to the position at that time occupied by the heart, at the metameric level of the fourth cervical to the first thoracic nerves (Fig. 178). It is in this location of their origin that we see the foundation of their characteristic innervation by the brachial plexus (Fig. 184). The leg buds make their appearance about the same time, but their development lags a trifle behind that of the arm buds (Fig. 178). In their formation at the level of the lumbar and first sacral segments the establishment of the sacral plexus is foreshadowed (Fig. 184). The muscular tissue of the appendages is derived through budlike outgrowths from the mesodermic somites at their metameric level (Fig. 182). Indications of the formation of digits first become apparent when the embryo has reached an age of about six to seven weeks (Figs. 179 and 180).

The embryos of all the higher vertebrates develop within a confined space. The growing body must conform itself to the limitations imposed by the egg shell, as in birds and reptiles, or the uterine cavity, as in mammals. It is not at all surprising, therefore, that young embryos show a marked tendency to become curled, head to tail. This process by which an embryo at first straight (Fig. 174) becomes bent into more or less the shape of a letter C, is called *flexion*. Flexion becomes apparent first in the cephalic region (Fig. 175, B) but soon thereafter, involves the entire body (Figs. 176–180). At certain points the bending is especially strongly marked. This has led to speaking, for convenience in description, of the cranial flexure, the cervical flexure, the dorsal flexure, and the lumbosacral flexure. These so-called *regional flexures* in reality grade into one another and are nothing more than local accentuations of a configuration which involves the entire body.

THE EARLY DIFFERENTIATION OF THE MESODERM

The mesoderm plays such an important rôle in the formation of so many parts of the body that its early differentiation demands special attention. It first makes its appearance between the ectoderm and entoderm in the posterior quadrant of the embryonic disc (Fig. 169, B).

As the development of this region is traced into slightly older stages it becomes apparent that this first proliferation center is the forerunner of the primitive streak—is in fact molded into the primitive streak. We are, there-

It is of interest to note in passing that the first part of the intra-embryonic coelom to be established is the region where the heart will develop. This

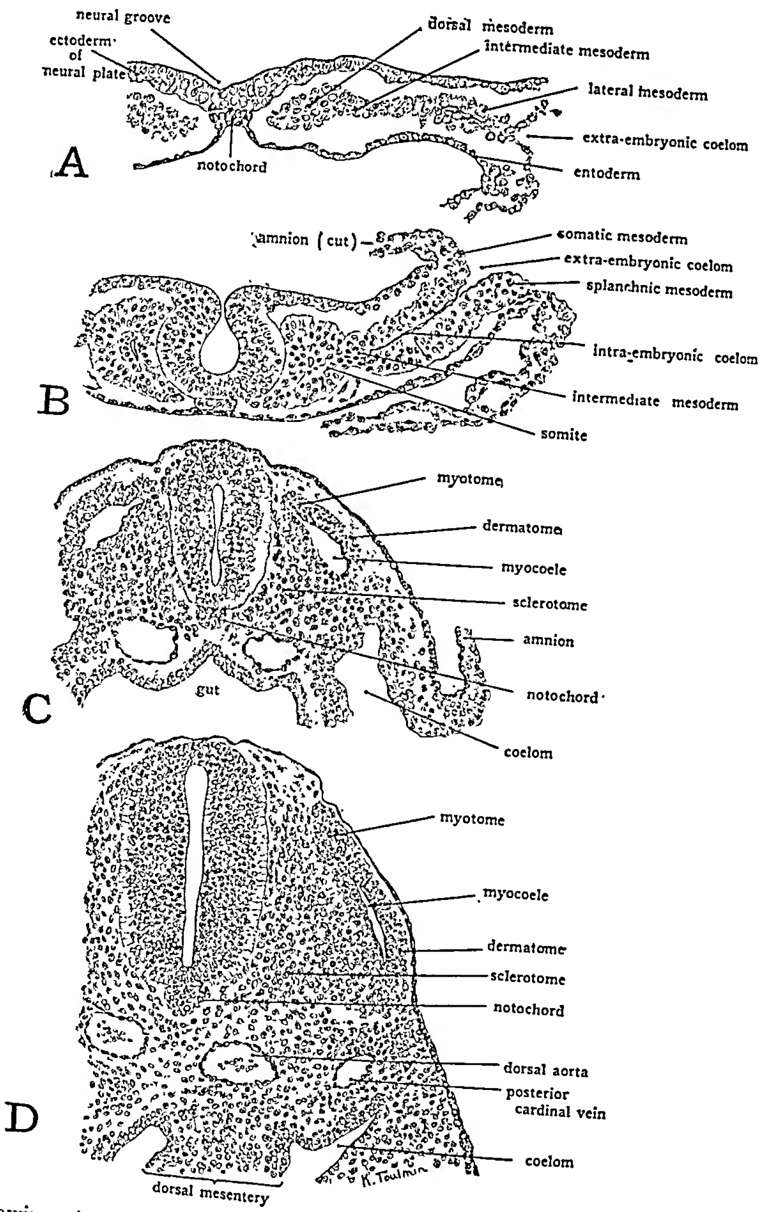

Fig. 181.—Drawings (× 120) of transverse sections of pig embryos of various ages to show formation and early differentiation of somites. From series in the Carnegie collection. A, Beginning of somite formation. B, Seven-somite embryo. C, Sixteen-somite embryo. D, Thirty-somite embryo. (From Patten, "Embryology of the Pig," published by P. Blakiston's Son and Co.)

precocious formation of the pericardial coelom presages the early appearance of the cardiovascular system as a whole. Equally striking is the early ex-

streak region progressively increases the length of the embryo, the first somites formed are carried cephalad in the general expansion of the embryonic body. Keeping pace with the increase in cephalocaudal elongation, more and more dorsal mesoderm becomes differentiated posteriorly, and new pairs of somites are added behind those previously established. The increase in number of somites in the human embryo between the sixteenth day when the first pair may be expected to appear and the thirtieth day when ordinarily thirty pairs have been formed, averages two pairs of somites a day. In other forms where accurate age determinations are possible, the somites are known to be formed at a fairly steady rate. While it is true that, as with all other growth processes, individual variability occurs and even litter-mates may have different numbers of somites, still on the average the somitic count proves to be the most generally useful index of developmental progress. The number of somites which have appeared, therefore, constitutes a valuable criterion for placing the relative stage of development of young human embryos, concerning which there is rarely available any trustworthy data as to fertilization age.

The cells in a somite are not destined to a common fate. In fact, these cells as a group have a wider diversity of developmental potentialities than any sharply localized aggregation of cells in the young embryo. It is, therefore, a matter of especial interest to see the various steps by which they become, so to speak, sorted out, grouped according to their potentialities, and finally highly specialized in various ways.

The initial mass of cells constituting a somite grows rapidly in bulk and the radial arrangement, at first vague, soon becomes clearly marked. At the same time the boundaries of the somite become more definite and a small lumen appears in its center (Fig. 181, B). This lumen, known as the *myocele,* increases in size until the somite appears as a hollow vesicle with thick outer walls (Fig. 181, C).

By this time local differences within the somite are becoming apparent. Three regions are recognized and named on the basis of their later history. The dorsomesial part of a somite is composed of cells which will form the skeletal muscles developing at that segment level of the body. For this reason it is called the *myotome* (Fig. 181, D).

The ventrolateral portion of the somite is made up of cells which have been believed to migrate out, become aggregated close under the ectoderm, and give rise to the connective tissue layers which underlie the epidermis. Accordingly it has been called the *dermatome* or *cutis plate.* While some cells from this region of the somite undoubtedly are contributed to the formation of the deep layers of the skin the conviction has been gaining ground that many, perhaps most of them, take part in the formation of muscle. Furthermore, the connective tissue layer of the skin is known to receive many cells from the somatic mesoderm generally, and from the diffuse mesenchyme in the cephalic region where there are no somites. The term "dermatome" is so firmly fixed that it is probably unwise to attempt to discard it, but we should bear in mind that, while it does contribute to the dermis, it probably does not do so any more extensively than other regions of the mesoderm which lie in close proximity to the ectoderm.

The third region of the somite is the so-called *sclerotome,* consisting of cells which migrate ventromesially from the original compact mass (Fig.

meet, a double fusion takes place. The mesial or neural plate components of the two folds fuse with each other and the lateral limbs, consisting of unmodified ectoderm, also fuse with each other (Fig. 181, B and C). Thus in the same process the original neural plate becomes the wall of the neural tube and the superficial ectoderm closes over the place formerly occupied by the open neural groove. Shortly after this fusion the neural tube and the superficial ectoderm become somewhat separated from each other leaving

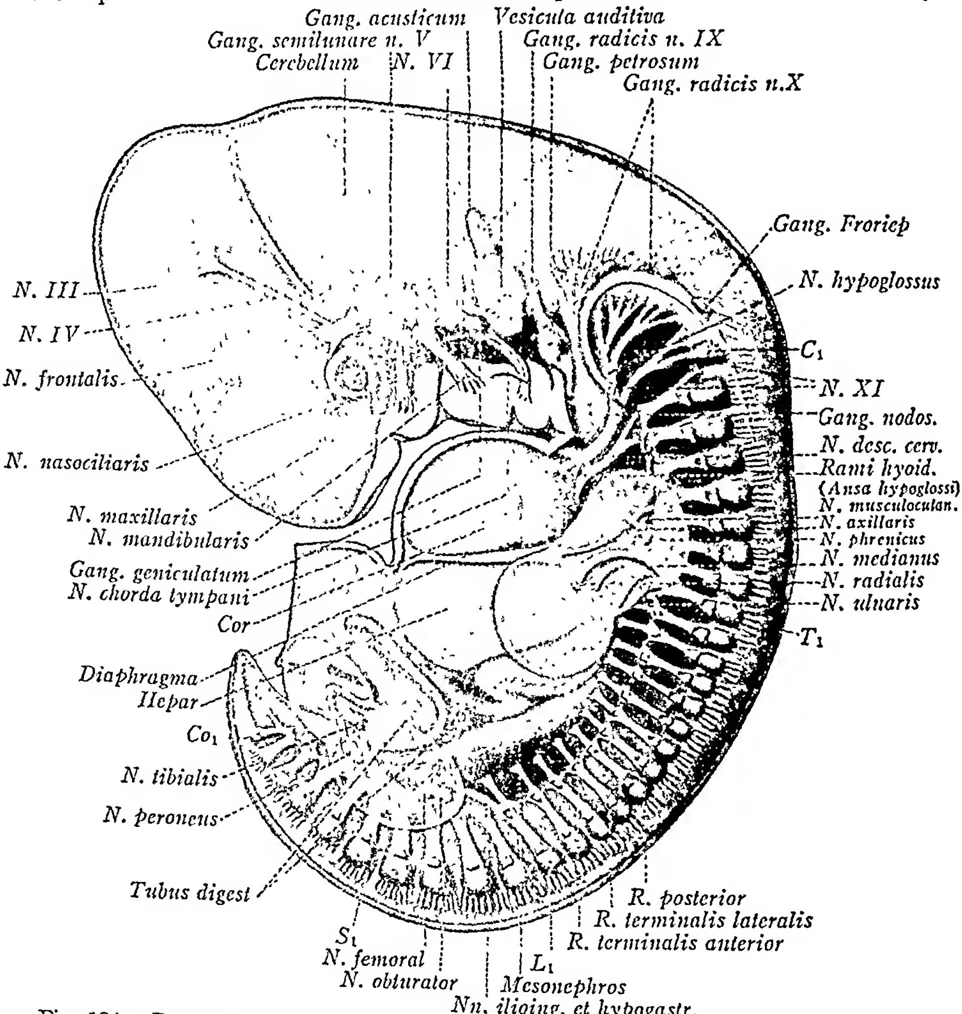

Fig. 184.—Reconstruction (× 12) of the nervous system of a 10-mm. human embryo. (After Streeter, Amer. Jour. Anat., 1908, vol. 8.)

no trace of their former continuity. Failure of this process to go to completion results in the malformation known as *rhachischisis*.

There are cells located near the apices of the neural folds which are not involved in the fusion of either the superficial ectoderm or the neural plate. These cells form a pair of longitudinal aggregations extending, one on either side of the midline, in the angles between the superficial ectoderm and the neural tube (Fig. 183, A and B). With the fusion which closes the neural

tube these two cell masses become, for a time, confluent in the midline (Fig. 183, C). But because this aggregation of cells arises from paired primordia and soon again separates into right and left components, it should be regarded as a paired structure. On account of its position dorsal to the neural tube it is called the *neural crest.*

When first established the neural crest is continuous anteroposteriorly. As development proceeds, its cells migrate ventrolaterally on either side of the spinal cord and at the same time become segmentally clustered. The metamerically arranged cell groups thus derived from the neural crest give rise to the dorsal root ganglia of the spinal nerves (Fig. 184), and in the cephalic region, to the ganglia of the sensory cranial nerves (Fig. 185).

The marked enlargement of the anterior portion of the neural plate has already been commented on. When the neural tube is formed from the neural plate, the anterior part of the tube is of larger diameter corresponding to the greater size of the plate in the future brain region (Fig. 174). Almost from its first appearance the brain shows certain indications of regional differentiation. In early stages three regions may be distinguished for the sake of convenience in description. These are the so-called *forebrain, midbrain,* and *hindbrain.* The *forebrain* (prosencephalon) is the broadest of the three because of the presence of the optic vesicles which arise as outgrowths from its lateral walls. In the extreme anterior portion of the forebrain complete closure of the neural folds is somewhat delayed, and there remains, for a time, an opening known as the *anterior neuropore* (Fig. 175).

Later in development the forebrain becomes differentiated into an anterior, telencephalic portion and a more posterior diencephalic portion. The anterodorsal parts of the telencephalon become very highly developed and give rise to the cerebral hemispheres (Fig. 185, E). Ventrally the growth is less marked and the olfactory tracts there located retain their primitive relationships. The diencephalic region is soon completely overshadowed by the enormous growth of the hemispheres and remains as the region of the third brain ventricle with the pineal body in its roof, the thalami constituting its lateral walls and the infundibulohypophyseal complex in its floor.

The *midbrain* (mesencephalon) is marked off by slight constrictions in the walls of the neural tube from the forebrain, and somewhat less distinctly, from the hindbrain. In young embryos the mesencephalon shows little indication of local specialization presaging the formation of specific structures. Its roof is destined to become thickened and differentiated into the corpora quadrigemina and along its floor will develop the extensive fiber tracts of the crura cerebri (Fig. 185, E).

Posteriorly the *hindbrain* or rhombencephalon grades without abrupt transition into the more slender part of the neural tube which will become the spinal cord. Its most interesting feature in early stages is the definite indication of neuromeric enlargements it shows, indicative of the fundamental metameric organization of the brain. The primitive hindbrain is later differentiated anteriorly into the cerebellum, and posteriorly into the medulla (Fig. 185, E).

At the extreme posterior end of the developing spinal cord, closure of the neural folds is delayed, just as it was anteriorly. The opening which thus persists for a time at the posterior end of the neural tube is known as the

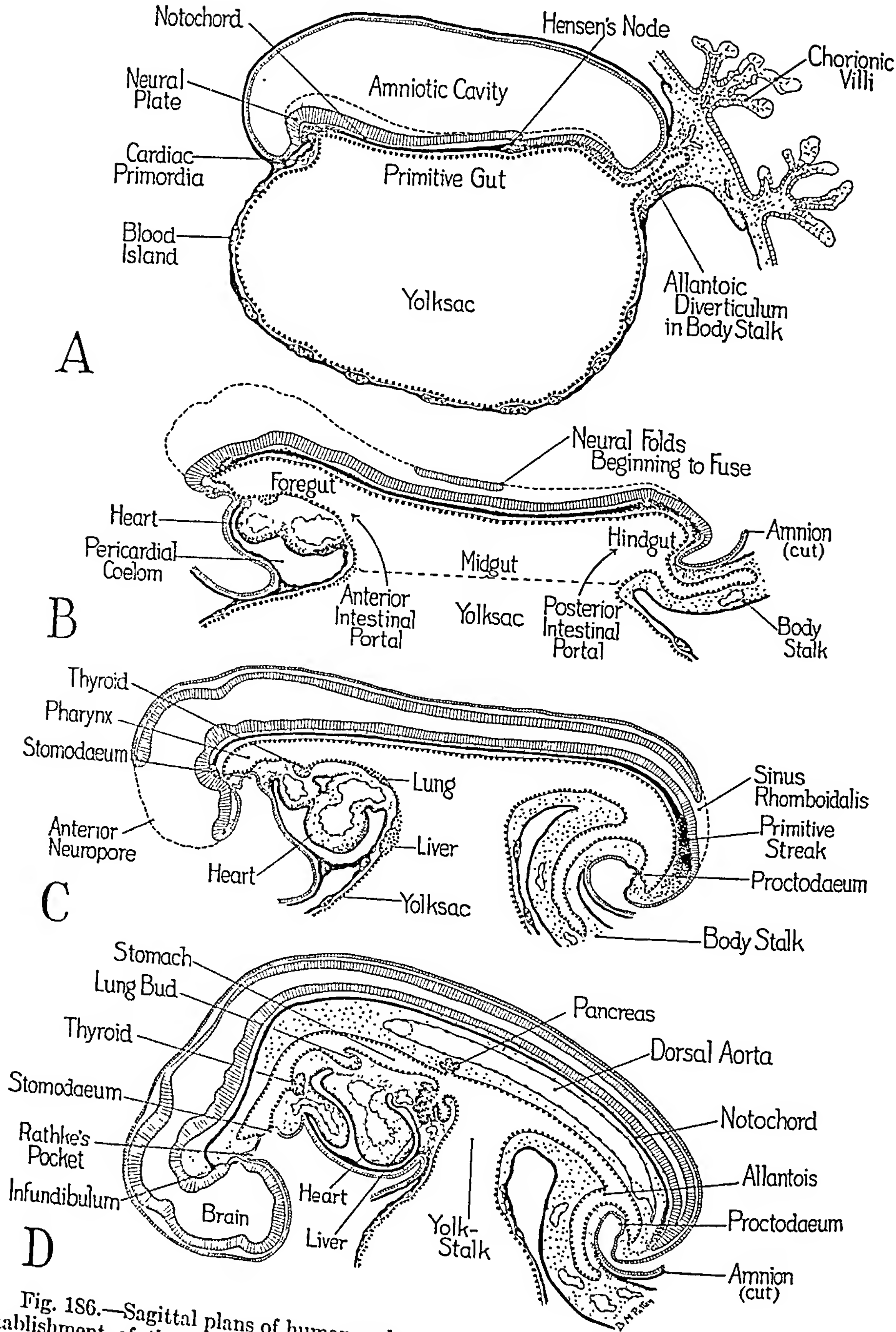

Fig. 186.—Sagittal plans of human embryos in the third and fourth weeks to show the establishment of the digestive system. A, At the beginning of somite formation, age about sixteen days. (Based on Carnegie embryo No. 5080, and on the Ingalls embryo.) B, Seven somites, age about eighteen days. (Based on the Payne embryo. See Fig. 174, B.) C, Fourteen somites, age about twenty-two days. (Based on the Heuser embryo. See Fig. 175, B.) D, At the end of the first month. (Based on Carnegie embryo No. 6097. See Figs. 176 and 188.)

openings. Soon, however, there appear two depressions in the surface of the body which sink in to meet the gut. One of these depressions, the *stomodeum*, is located on the ventral surface of the head in the future oral region. The other, the *proctodeum*, is located caudally in the future anal region (Fig. 186, C).

The stomodeal depression gradually becomes deeper until its floor makes contact with the entoderm of the foregut. The thin layer of tissue formed by the apposition of stomodeal ectoderm to foregut entoderm is known as the *oral*, or *stomodeal, plate*. Not long after the first appearance of the stomodeum, the oral plate ruptures, establishing the anterior opening of the gut (Fig. 188). Growth of the surrounding structures further deepens the original stomodeal depression and it becomes the oral cavity. The region of the oral plate in the embryo becomes, in the adult, the region of transition from oral cavity to pharynx.

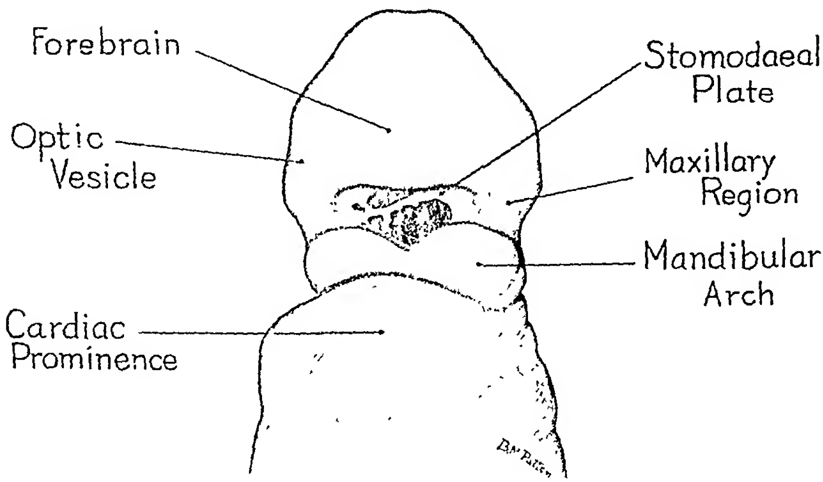

Fig. 188.—The breaking through of the stomodeal plate to establish the oral opening into the foregut. Face view of four-week embryo No. 6097 in the Carnegie collection, drawn (× 30) from stereophotographs. (Compare Fig. 176 which is a side view of the same embryo and Fig. 186, D.)

Somewhat later in development than the time at which the oral opening is established, the proctodeum breaks through to the hindgut, forming the *cloacal opening*. Subsequent differentiation in this region results in the separation of the originally single cloacal aperture, into anal and urogenital openings. Thus, early in the second month we find the embryo with its digestive tract well established.

The Circulatory System

The mammalian embryo, having practically no yolk available as food, is dependent for its survival and growth on the prompt establishment of relations with the circulation of the mother. This implies the necessity of a

the foregut. The fact that the heart, a median unpaired structure in the adult, arises from paired primordia which at first lie widely separated on either side of the midline, is correlated with the fact that the embryonic body at first is open ventrally and lies spread out prone on the surface of the yolk sac. The primordia of certain anatomically ventral structures arising at an early stage of development, therefore, first appear as separate halves lying on either side of the midline. With the folding under of the lateral margins of the embryonic area, which brings the ventrolateral walls of the body into their definitive position, the embryo is closed ventrally, and potentially midventral structures which arose as separate halves are established in the midline.

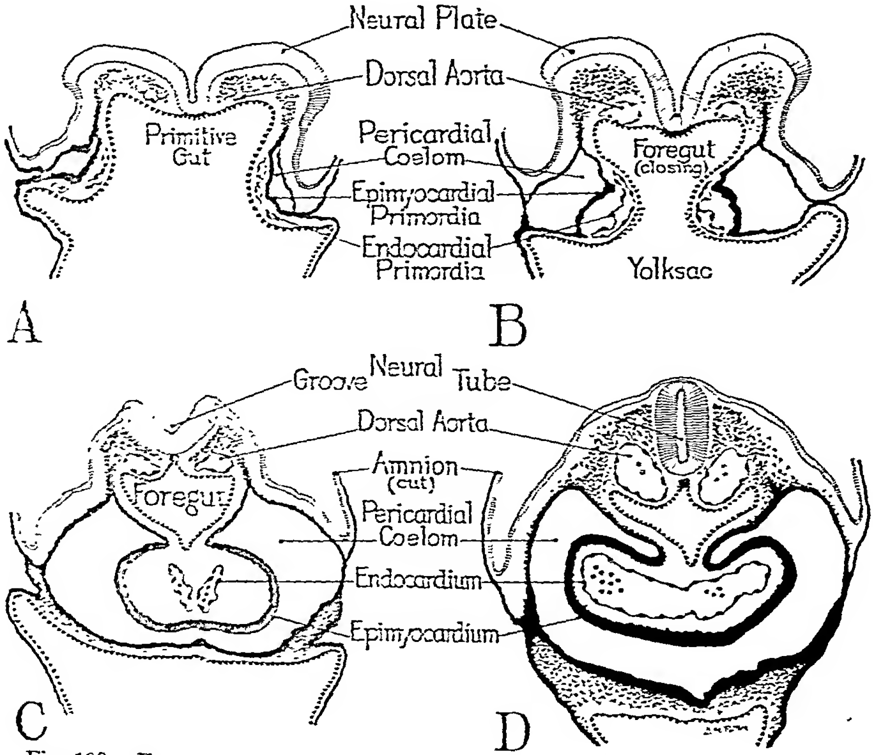

Fig. 190.—Four stages in the fusion of the paired primordia of the heart as seen in cross section. A, Based on the Ludwig, two-somite embryo. B, Based on the Carnegie No. 3709, four-somite embryo. C, Based on the Payne, seven-somite embryo. D, Based on the Corner, ten-somite embryo.

The primordial heart is double-layered, as well as paired right and left. The inner layer is called the *endocardium* because it is destined to form the internal lining of the heart. The outer layer is known as the *epimyocardium* because it will give rise both to the muscular layer of the heart wall and to its epicardial investment.

The endocardium appears first in the form of irregular clusters and cords of mesenchymal cells lying between the splanchnic mesoderm and the endoderm. These cells become organized into two main strands lying one on either side of the gut. Soon after their establishment these strands acquire a lumen and are known as the *endocardial tubes* (Fig. 190, A). The endocardial

cardinal veins on either side of the body become confluent as the *common cardinal veins* or *ducts of Cuvier.* The common cardinals are short trunks which at once turn ventromesiad and enter the posterior part of the heart (Fig. 191).

In addition to the vessels limited in their distribution to the body of the embryo, there are conspicuous channels leading beyond the confines of the body to the yolk sac and to the placenta. The main arteries from the aorta to the yolk sac are called the *omphalomesenterics* and their terminal branches the *vitellines.* The main vessels leading to the placenta are known as the *allantoic* or *umbilical arteries.*

In the splanchnopleure of the yolk sac the main omphalomesenteric vessels are continuous with a rich plexus of small tributaries, the *vitelline vessels.* These smaller blood vessels can be traced into prevascular cords of meso-

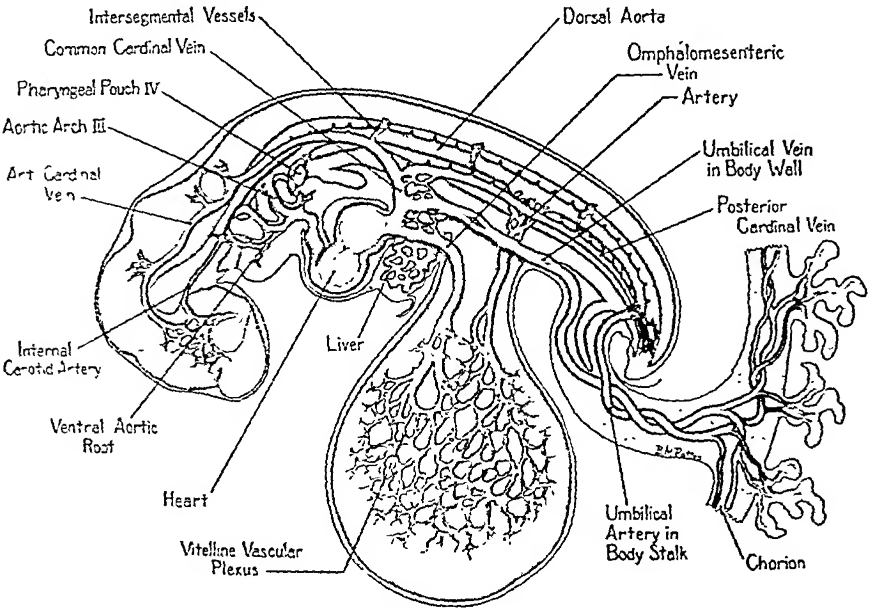

Fig. 191.—Semischematic diagram to show the basic vascular plan of the human embryo at the end of the first month. For the sake of simplicity the paired vessels are shown only on the side toward the observer.

dermal cells as yet not hollowed out. In these cellular cords are frequent knotlike enlargements, known as *blood islands,* containing not only cells which are destined to form vascular endothelium, but also cells which will give rise to blood corpuscles. In the differentiation of a blood island the peripherally located cells become flattened and somewhat separated from the rest of the mass. Eventually they become arranged as a coherent investing layer, a single cell in thickness, and clearly endothelial in nature. Meanwhile fluid accumulates inside the endothelium and the enclosed centrally located cells of the original mass become rounded and take on the characteristics of primitive blood corpuscles.

As the endothelial vesicles enlarge they become confluent with other similarly differentiating vesicles with the resulting formation of a plexus of freely anastomosing endothelial tubes, the *primordial capillary bed* of the

thus bringing the blood into intimate relation with the developing tissues. The blood is then collected by the cardinal veins and returned by way of the ducts of Cuvier to the heart.

The other two arcs are the vitelline, which runs to the yolk sac, and the allantoic or umbilical to the chorion (Fig. 191). Both these arcs start within the embryo, for the heart serves as a common receiving and pumping station, and the aorta as a common distributing main for all three of the circulatory arcs. But because their main vessels extend outside the body with their terminal ramifications in the extra-embryonic membranes these latter arcs are ordinarily spoken of as extra-embryonic.

In the embryo as in the adult the main vascular channels lead to and from the centers of metabolic activity. The circulating blood carries food from the organs concerned with its absorption to parts of the body remote from the source of supplies; oxygen to all the tissues of the body from organs which are especially adapted to facilitate the taking of oxygen into the blood; and waste materials from the places of their liberation to the organs through which they are eliminated. One of the primary reasons the arrangement of the vessels in an embryonic mammal differs so much from that in the adult, is the fact that the embryo lives under conditions totally unlike those which surround its parents. Its centers of metabolic activity are, therefore, different; and, since the course of its main blood vessels is determined by these centers, the vascular plan is different. No such profound changes occur between the embryonic and the adult stages in the circulation of a fish where embryo and adult are both living under similar conditions.

The organs which in the adult mammal carry out such functions as digestion and absorption, respiration, and excretion are extremely complex and highly differentiated structures. They are for this reason slow to attain their definitive condition and are not ready to become functional until toward the close of the embryonic period. Moreover, the conditions which surround certain of the developing organs during intra-uterine life absolutely prevent their becoming functional even were they sufficiently developed so to do. Suppose the lungs, for example, were functionally competent at an early stage of development. The fact that the embryo is reliving ancestral conditions in its private amniotic aquarium renders its lungs as incapable of functioning as those of a man under water.

An embryo must, however, solve the problem of existence during the protracted time in which it is building up a set of organs similar to those of its parents. In the absence of a dowry of stored food in the form of yolk, the mammalian embryo draws upon the uterine circulation of the mother. Utilization of this source of supplies depends on the development of a special organ which serves through fetal life and is then discarded. The embryo takes food not into its slowly developing gastro-intestinal tract but into its chorion.

The use of food materials to produce the energy expressed in growth depends on the presence of oxygen. For growth there must be a means of securing oxygen and carrying it, as well as food, to all parts of the body. Nor can continued growth go on unless the waste products liberated by the developing tissues are eliminated. The blood of the embryo cannot be relieved of its carbon dioxide and acquire a fresh supply of oxygen in the primordial cell clusters which will later become its lungs. It cannot excrete

appearance of a full complement of aortic arches, or their subsequent disappearance to make way for a new respiratory circulation in the lungs. We see the march of progress from a logical beginning in ancestral conditions toward the consummation of fetal life with an organization like that of the parent.

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The appended list of references by no means constitutes a bibliography of the subjects touched upon in the foregoing chapter. Since the chapter was written not as a technical contribution, but merely as a summary of some of the outstanding features of the early phases of human development, neither formal documentation nor a lengthy bibliography seemed desirable. The references cited do, however, comprise all the major direct sources consulted, and, since most of the articles referred to contain bibliographies in their special fields, the door to the literature is at least left ajar for one who wishes to enter.

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CHAPTER XIV

PLACENTATION, FETAL MEMBRANES AND DECIDUAE

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The young of all vertebrate animals are confronted with the necessity of insuring the continuation of development until the time arrives when they may safely assume an independent existence. The problem is simplest for the lowest forms, like fishes and amphibia, which grow rapidly to immature free-swimming individuals; for this reason they need no accessory organs other than a yolk sac filled with nutriment sufficient to last until independent foraging is possible. All other vertebrates are much farther advanced in structure at birth, and accordingly they elaborate additional prenatal organs. A comparative study through the several vertebrate groups of the steady advances in complexity, especially those due to an increasing dependence upon the mother, constitutes a most fascinating subject, without some knowledge of which a correct understanding of the specialized conditions in mammals and man is scarcely possible. Unfortunately only the barest allusions to such comparative conditions can be included here; a concise account may be found in another contribution by the present writer[1] while a more extensive review has been made available by Grosser.[2]

The full set of fetal organs includes the yolk sac, allantois, amnion, and chorion. They have to do with the protection, nutrition and respiration of the embryo, and with the removal of its katabolic wastes. Yet the function of any one of these organs is not fixed unalterably. The yolk sac, allantois, and chorion have variable values and uses in the several vertebrate groups; only the function of the amnion is relatively stable. Most striking is the way in which the chorion of the highest mammals has been utilized in conjunction with the uterine mucosa for the elaboration of a placenta which takes over all the vital intermediary functions and relegates both yolk sac and allantois to the status of essentially outmoded organs.

The present chapter will deal with the penetration and implantation of the mammalian embryo within the uterine wall, the elaboration of fetal membranes and allied appendages by the embryo, the modification of the pregnant uterine mucosa into the decidual membranes, and, in particular, the development of the all-important placenta. Except when specifically stated to the contrary, the descriptions will refer to the human subject.

IMPLANTATION AND EARLY PLACENTATION

The mammalian ovum is fertilized in the upper end of the uterine tube and the ensuing cleavage stages are already under way during the downward passage toward the uterus. The time consumed in the tubal portion of the journey appears to be independent of the size of the egg or the length of the tube,[3] but is rather constant for certain mammalian groups.[4] With regard

in view of the predilection to these locations. Perhaps the spot must be lacking in cilia, so that the embryo becomes stranded.

The young embryonic mass of man is ready to implant about ten days after fertilization.[5] At this time the uterine mucous membrane is in the succulent premenstrual condition, characterized by general thickening, vascular engorgement and the presence of elongate, convoluted glands swollen with discharged secretion (Fig. 192). Bordering the uterine lumen there is a relatively compact stratum, whereas the deeper levels of the mucosa are more spongy. The endometrium is also sensitized under hormonal influence to receive the embryo and react (by the formation of deciduae) to the stimulation of its entry. All these preparations would appear to be favorable for the implantation of the embryo, while the increased glandular secretions, con-

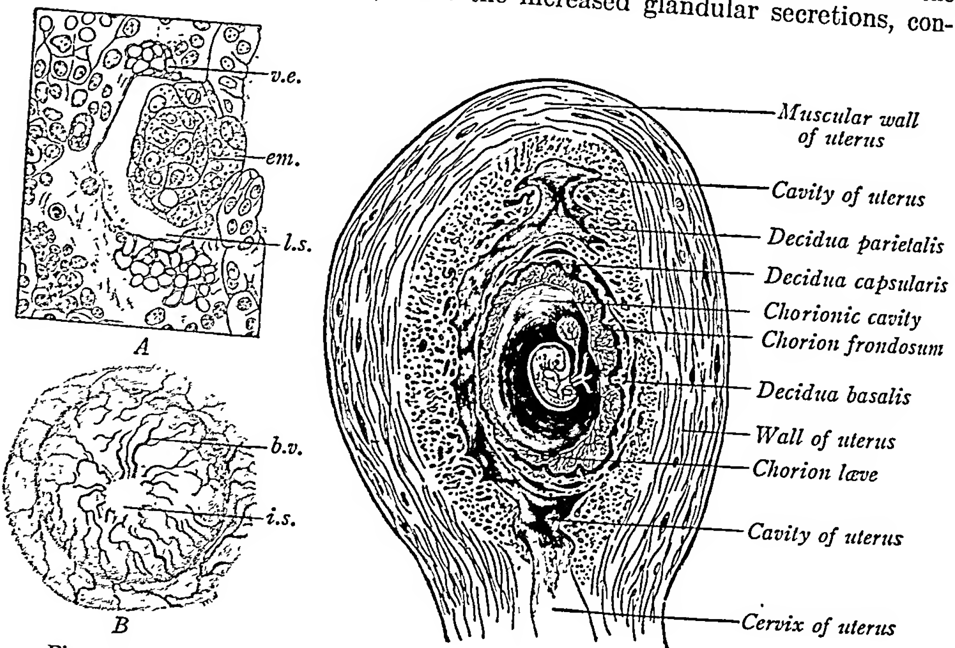

Fig. 193.—*A*, Penetration of the uterine mucosa by the guinea-pig ovum (× 230). (After Spee.) *em.*, Embryo; *l.s.*, 'lymph' space; *v.e.*, vacuolate embryotroph. *B*, Uterine lining with implanted human ovum in surface view (× 5). (After Meyer.) *b.v.*, Blood vessels of decidua capsularis; *i.s.*, implantation site. *C*, Section of the gravid uterus showing the relations after implantation and several weeks' growth. (After Thompson.)

taining glycogen, may well afford preliminary nutriment for its growth.[12] Possibly the discharged glycogenic secretion is even utilized during the uterine sojourn of the embryo, before the beginning of implantation.

Penetration into the Endometrium.—It must be emphasized that no human specimens have yet been recovered to illustrate the stages beginning with fertilization and extending to a time shortly after lodgment (*implantation*) within the uterine mucosa has been accomplished (*cf.* Figs. 194, *D*, *E*, and 196). The actual penetration is supposed to occur at about the tenth day after fertilization[5]; yet there doubtless is considerable departure from this 'normal' time in certain instances, just as ovulation may occur earlier or later than the mean characteristic period. Although the passage of the hu-

planted embryo in the endometrium is relatively superficial and in no case encroaches beyond the compact stratum (Fig. 193, *B*, *C*).

Early Relations Between Embryo and Endometrium.—Even by the time when the penetration of the uterine mucosa is fully accomplished, and the young embryonic mass lies in the substance of its more superficial, compact layer, the trophoblastic covering of the embryo has effected considerable change in the adjacent maternal tissues. These appear to be undergoing dissolution, as if by digestive action (Fig. 193, *A*). As the result of this process the embryo is surrounded by disintegrating, liquefying mucosal elements in which vacuoles appear and coalesce, to give rise to spaces filled with an emulsion of blood and cellular débris. This material is named the *embryotroph* since it is absorbed directly by the trophoblast and serves as food for the embryo until such time when a more efficient nutritive mechanism is perfected.

Immediately upon locating within the endometrium the embryo and its encapsulating sac of trophoblast enter upon a phase of rapid growth. This requires additional room which is straightway created partly by simple

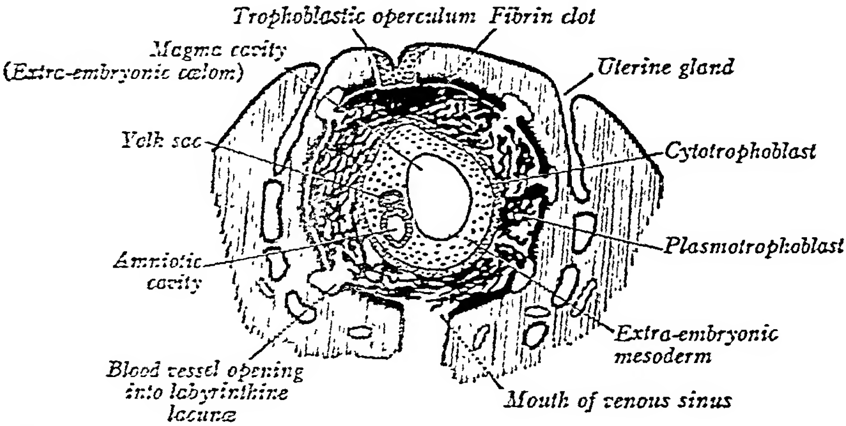

Fig. 195.—Semidiagrammatic section through the Bryce-Teacher human embryo of about fourteen days *in situ* (× 35). (After Woollard, from Teacher.)

expansion (Fig. 193, *B*, *C*) but also through the destruction of more maternal tissue (Figs. 194, *D*, *E*, and 197). It is the latter process that is especially significant, since through it additional embryotroph is provided and blood sinuses are established which make possible a much more efficient (hemotrophic) type of nutrition and the development of a placenta. The tissue responsible for erosion is the trophoblastic capsule which, it must be understood, never becomes a part of the embryo proper. Originally this trophoblast was simple ectoderm but by proliferation it develops rapidly into a thick, spongy, cellular layer. The youngest human specimens known have just completed this stage of development (Fig. 194, *D*, *E*). Very early in the trophoblastic growth-process the original cellular layer (*cytotrophoblast*) begins to transform into syncytium (*plasmotrophoblast*). However, the innermost part of the trophoblast, next the extra-embryonic mesoderm, is never concerned in this transformation but still remains cellular (Fig. 195). In the ten days following penetration, before the definitive, hemotrophic

cytium since it will presently serve to extract nutrient materials from the maternal fluids, rather than to continue the erosive function. In passing, one may emphasize that it seems improbable that trophoblast which has once engaged in the destruction of decidua can later clothe villi and assume an absorptive rôle. The *blood lacunae*, just mentioned, are not lineal continuations of the earlier spaces in the trophoblastic sponge work but are apparently newly created by the trophoblast and are the direct progenitors of the intervillous spaces of later stages.

It is apparent that at the period represented by the Peters embryo, the general attack on the yielding maternal mucosa is continued by the growing cytotrophoblast (Fig. 197). Additional stroma and glandular epithelium

Fig. 197.—Portion of the chorionic capsule of the Peters' ovum to illustrate the invasion of the maternal tissues (× 520). (After Peters.) *ect.*, *mes.*, Ectoderm and mesoderm of chorionic wall continued into cellular strands of cytotrophoblast (*tr*) which in turn have produced syncytial plasmotrophoblast (*sy*). Maternal tissue already eroded has given way to blood lacunae (*B. L.*); below, the syncytium is seen tapping a hitherto intact capillary (*ca*) next the unaltered decidua basalis (*d.b.*).

are destroyed and converted into supplementary embryotroph. Blood vessels, hitherto intact, are tapped and additional sinuses formed; an outstanding characteristic of all trophoblast is that, like endothelium, it does not aggravate blood into clotting. Wherever the several processes are going on there is a transitional zone in which trophoblastic and endometrial tissues mingle; there is destruction of both, although naturally the greater loss is to the maternal elements. The period of penetration into the organizing decidua reaches its height at the time when the second generation of cytotrophoblast is most abundant. Such a stage is illustrated by the Mateer embryo (nineteen days old) in which the primitive streak is present.[18] Penetration declines toward

early stage in the outer, mesodermal component of the yolk sac (Fig. 201); in fact, they represent the earliest blood-vascular elements and are already

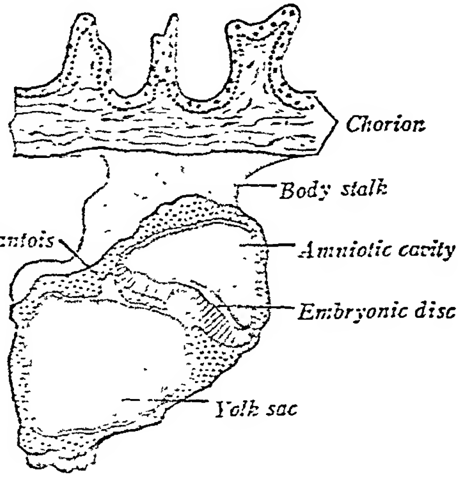

Fig. 200.—Model of the left half of a human embryo at an early stage of the primitive streak (× 75). (After Möllendorff.)

differentiating at a time when the embryo is still without mesodermal somites (e. g., the Spee specimen of twenty-one days). These blood vessels organize

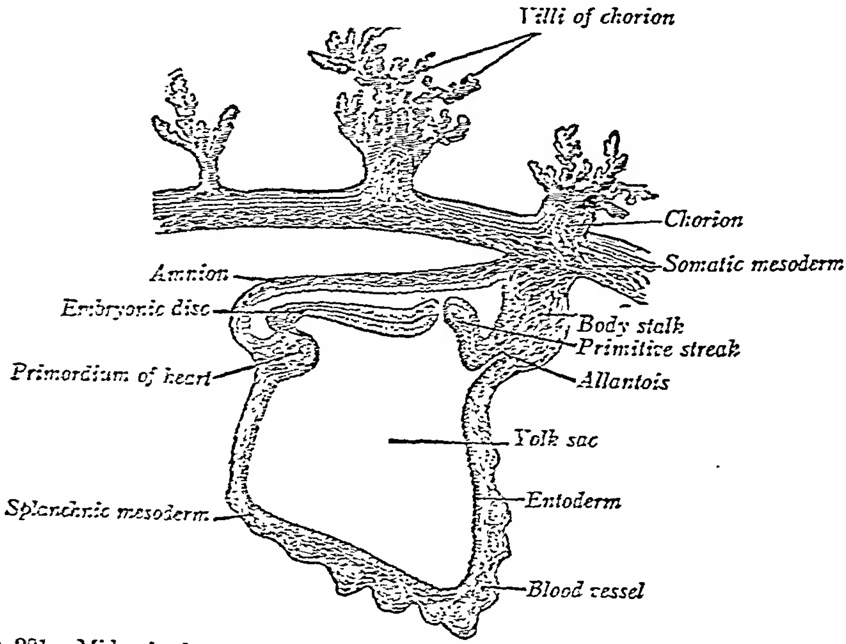

Fig. 201.—Midsagittal section of Spee's 1.54 mm. human embryo (× 23). (After Spee.)

into a prominent plexus which connects with the vitelline vessels of the embryo. They have no known necessary significance beyond blindly repeating an outmoded ancestral characteristic.

size of about 5 mm. by the middle of the second month; it may measure twice this diameter (Fig. 205). At about this time the simple entodermal lining proliferates into the external covering of connective tissue and forms branching buds, tubules, and cysts of glandular appearance but of unknown significance. In the meanwhile the epithelium has become taller and sometimes vacuolate; finally it shows stratification and then disappears, so that after the second month the wall of the yolk sac is merely fibrous connective tissue. The yolk sac subsequently shrinks somewhat and converts into a solid structure containing detritus. It usually persists throughout pregnancy and may be found variably situated in some portion of the after-birth, most often near the umbilical cord (Figs. 219 and 221, *A*).

In two per cent of all adults there is a persistence of the proximal end of the yolk stalk to form an intestinal pouch, Meckel's *diverticulum of the ileum.* This arises some two feet above the union of ileum and colon. Although usually a blind sac and but a few centimeters long, the diverticulum may extend to the umbilicus as a continuous cord. Still less frequently it opens at the navel as a completely pervious duct through which intestinal contents escape; this condition constitutes a fecal *umbilical fistula.* Meckel's diverticulum is important surgically as it sometimes telescopes into the intestinal lumen and obstructs it. In other instances when the diverticulum extends to the umbilicus, or when its free end fuses to an adjacent peritoneal surface, the band so formed may catch and strangulate a loop of the small intestine.

The Allantois.—Reptiles, birds, and many mammals produce an allantois by the outward sacculation of the splanchnopleure of the hindgut into the extra-embryonic body cavity. In carnivores and hoofed mammals it becomes very large and lines the chorionic sac; a striking example is furnished by a goat embryo which when two inches long has an allantois measuring two feet. The further history of such conspicuous allantoic sacs is bound up with the development of a placenta which, accordingly, differs in its composition from that of man and some other mammals.

The allantois is not represented in the youngest human embryos known. Nevertheless, it does appear very early, even before the gut has begun to assume a tubular form (Fig. 200). In the Spee human embryo, three weeks old, the allantois is a slender entodermal tube located caudally near the dorsal surface of the yolk sac and extending into the mesoderm of the body stalk (Fig. 201). Because of so precocious an origin it does not develop as a direct evagination of the hindgut into the extra-embryonic coelom; since, however, the body stalk represents mesoderm into which the coelom has failed to penetrate, the fundamental relations are similar to those in lower animals (Fig. 199, *D*). The human allantois never becomes saccular. It extends as a tube within the body stalk as far as the chorion, and when the developing umbilical cord includes the allantois as a component, it is at first as long as the cord itself (Figs. 207 and 212). However, growth of the allantois soon ceases. In embryos of 8 mm. its lumen becomes beaded in contour, after which interruption and obliteration enter. In the fourth month allantoic remnants, some with lumina, are discernible in the proximal part of the umbilical cord, while even at term epithelial pearls and occasional coils, said to be of allantoic origin, occur (Fig. 208). In general, allantoic remnants are located centrally in the umbilical cord whereas the remains of the yolk stalk are more peripheral in position.

later (e. g., the Peters embryo) an extra-embryonic space begins to separate somatic and splanchnic layers of mesoderm (Fig. 199, *C*). Progressive enlargement of this coelomic cavity splits the mesoderm around the embryonic mass, and by the end of the third week of development the primitive ectodermal roof of the amnion cavity is covered with somatic mesoderm (Figs. 199, *D*, and 201). The final result is, therefore, identical with amnion formation by the method of folding. It may be added that deer and sheep derive an amnion by a method which combines hollowing and folding.

As already intimated, there is at first a broad mesodermal union between the primitive amnion and the external capsule of trophoblast (Fig. 200). This, however, becomes rapidly reduced by the continued extension of the coelomic cavity, and within a few days from the first appearance of the coelomic cleft only a narrow mesodermal bridge is left at the caudal end of the embryo. Such a stretch of uncleft mesoderm, into which the allantoic

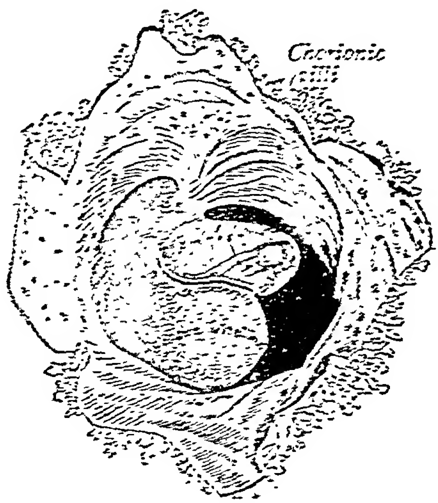

Fig. 204.—Chorionic sac opened to display a human 2.15 mm. embryo *in situ* (X 6). (Corning, after Coste.) *B.S.*, Body stalk.

tube and its accompanying vessels grow, is the *body stalk* (Figs. 201 and 204).

Hence, due to its peculiar manner of formation, the human amnion cavity is presumably closed from the beginning. The edge of the amnion is attached to the periphery of the embryonic disc which also serves as a floor to the amniotic cavity. The amnion becomes a thin, transparent, nonvascular membrane (Fig. 202) which is covered externally with connective tissue (and bordered, next the extra-embryonic coelom, with a mesothelium) and is lined with a simple type of ectodermal epithelium. For a time this epithelium is flat, but by the middle of pregnancy it is cuboidal and still later columnar. Its greatest height is over the placental area. Granules and fat droplets are demonstrable within the epithelial cells and a correlation with suspected secretory and nutritive activities has been claimed by some. The amniotic cavity enlarges rapidly at the expense of the extra-embryonic coelom (Figs. 204 and 205) and at the end of the second month it fills the chorionic sac

mammals that formed an amnion by a hollowing of the embryonic cell mass convert the blastocystic shell (composed of ectodermal trophoblast) directly into a chorion; only an internal lining of extra-embryonic mesoderm needs to be added (Fig. 199).

The trophoblast of the youngest known human embryos is already giving rise to the outer syncytial layer (Fig. 195), but the characteristic mesodermal component of the chorion is not added as such until the mesoderm becomes cleft by the extra-embryonic coelom. When this occurs, toward the end of the third week, the outer (somatic) layer of mesoderm lines the chorion and the relation of these layers to both amnion and embryo is then like that in lower vertebrates (Fig. 199, *D*). A characteristic feature of the chorion is the villous processes. The early *primary villi* are solid trophoblastic cords (Fig. 197), but these are soon replaced by *secondary*, or *true villi* which are branching outgrowths with central cores of mesoderm enveloped by trophoblast (Fig. 201). In early stages the total number is 400 or more. Blood vessels appear in the mesodermal axes and these allantoic (future umbilical) vessels connect through the body stalk with the body of the embryo (Fig. 212). The chorion becomes a rapidly growing, shaggy sac (Figs. 204 and 205) whose further history is inseparably linked with the development of the placenta; the latter will be described in later paragraphs.

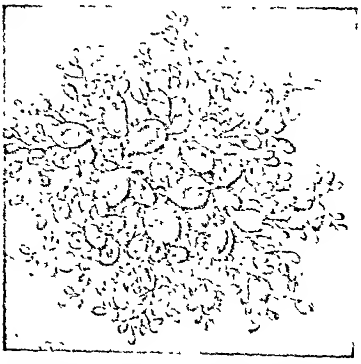

Fig. 206.—Vesicular or hydatidiform mole (× ½). (After DeLee.)

Occasionally there is a degeneration of the chorionic sac through which the villi become transformed into series of watery bladders somewhat the size of a pea. This constitutes a *vesicular* or *hydatidiform mole* (Fig. 206).

The Umbilical Cord.—As the embryo enlarges progressively, its ventral unclosed area becomes relatively smaller and even gives the false impression of undergoing a constriction (Fig. 207, *A*, *B*). This region, at the junction of embryonic and extra-embryonic territory, is the primitive *umbilicus*. At its margin the amnion and the somatopleuric belly wall become continuous and through its unclosed ring extend the yolk stalk and body stalk (plus the contained allantois). During the sixth week a cylindrical structure, the *umbilical cord*, comes into existence through the wrapping of the amnion around the body stalk and yolk sac (Figs. 205 and 207, *C*).[23] This cord has commonly been described as a direct outgrowth or extension of the body wall which carries the amnion before it, so that the amnion attaches merely at the distal end. On the contrary, the interpretation just given is now urged as correct. The umbilical cord, once formed, encloses both the yolk stalk and the body stalk (and allantois), together with a portion of the coelom (Fig. 207, *C*). The latter space will presently be obliterated by the encroachment of the peculiar jelly-like connective tissue which develops from the mesenchyme and characterizes this fetal appendage. This obliteration marks the final separation between the intra- and extra-embryonic coelom. Until the end of gestation the umbilical cord continues to connect the fetus to that part of

ous or cuboidal) and contains, embedded in mucous tissue, the following structures (Fig. 208): (1) the yolk stalk (and in early stages its vitelline vessels); (2) the allantois (and the body stalk which contained it); (3) the allantoic, or umbilical blood vessels (two arteries and a single, larger vein). The *mucous tissue*, or jelly of Wharton, peculiar to the umbilical cord, differentiates from mesenchyme; it is rich in mucoid jelly, poor in fibers and bears neither blood vessels nor nerves. Between the sixth and tenth weeks the intestine occupies an extension of the coelom within the umbilical cord and forms a temporary hernia there (Fig. 208, *A*). After the gut is withdrawn, the cavity of the cord rapidly disappears. In the early months of pregnancy remnants of the yolk stalk and allantois are to be seen and these may continue even to birth (Fig. 208, *B*).

The mature cord is about two-thirds inch in diameter and attains an average length equal to that of the full-term fetus (about two feet). The extremes of length may, however, range from almost nothing to six feet. The minimum length compatible with a normal delivery is slightly more than one foot. A spiral twist appears early and these proceed much more

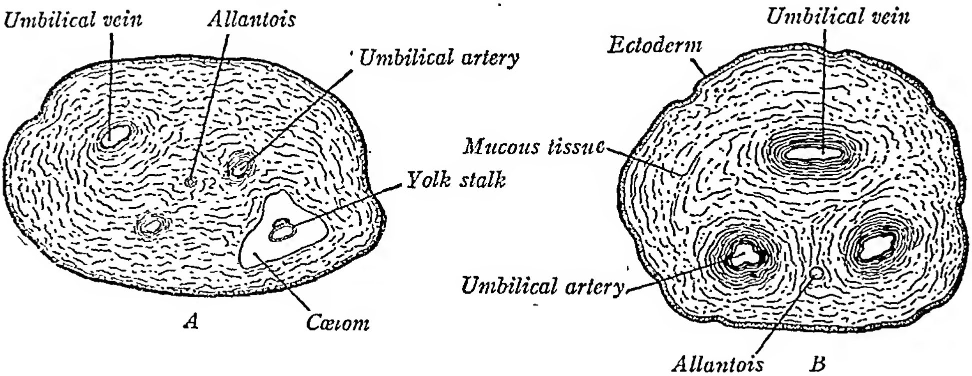

Fig. 208.—Transverse sections of the human umbilical cord. *A*, At six weeks (× 15); *B*, at full term (× 3). (Arey, 'Developmental Anatomy.')

frequently in a counter-clockwise direction when traced toward the placenta (Fig. 221, *A*). Although at maturity the cord may have as many as forty turns, the number is very variable. Unequal growth in length of the two arteries is usually held to be at least chiefly responsible for the early spiralling, but some other factors have been proposed as well.[24] The blood vessels frequently curl in loops (by stronger local growth, or perhaps, in part, by a local unwinding) which cause external bulgings designated *false knots* (Fig. 221, *A*). Sometimes the fetus slips through a stiff looped cord in such a manner as to produce a *true knot* (Fig. 221, *A*). The insertion of the umbilical cord on the placenta is usually slightly eccentric; it may attach to the margin or even on the adjoining membranes (Fig. 220, *A*, *B*). Schultze's fold is a sickle-shaped fold of the amnion which extends from the root of the cord onto the placenta and marks the passage of the former yolk stalk. Hence the remains of the yolk sac are frequently found in relation to the base of this fold.

Failure of the intestine to retract from its temporary location in the umbilical cord results in an umbilical hernia, while a secondary hernia after

an ordinary menstrual cycle. The two processes show undoubted fundamental similarities and the decidual membranes are a direct continuation of the already modified premenstrual mucosa.

Even when the early chorionic vesicle lies embedded within the uterine mucosa three regions of this thickened membrane can be recognized (Figs. 209 and 212): (1) the *decidua parietalis* (or decidua vera), the general lining of the uterus exclusive of the region of the embryo; (2) the *decidua capsularis* (at one time called the decidua reflexa), a portion that covers the implanted embryo; with the growth of the embryo it makes a dome-like covering over the chorion and stands between the latter and the uterine cavity; (3) the *decidua basalis* (formerly called the decidua serotina), a region underlying the embryo and situated between the chorionic sac and the muscular wall. Since the presence of the enlarging ovum has separated the decidua capsularis away from the decidua basalis, neither of these two decidual membranes contains all the constituents of the typical endometrium. In addition, some writers have designated the transitional zone where the capsularis, basalis, and parietalis all meet as the decidua marginalis; it is here that circumferential growth of the placenta occurs.

Dissections of an entire, aborted set of deciduae, containing a young chorionic sac, are shown in Fig. 211. From them many fundamental relations can be obtained.

The Decidua Parietalis.—The premenstrual mucous membrane undergoes a marked enlargement and specialization, as already described in an earlier chapter. The superficial *compact layer* and deeper *spongy layer*, thus produced, are still further emphasized in pregnancy and these elaborations are not limited to the region of the embryo (Fig. 210, *A*). The general, nonplacental lining of the gravid uterus has long been called the *decidua vera* but the term is in no sense appropriate; *decidua parietalis,* to be used in this account, is descriptively more correct. The compact layer contains the straight, vertically placed, but dilated segments of the uterine glands. Its surface epithelium disappears by the end of the third month, at which time contact with the expanding decidua capsularis takes place. The spongy layer is characterized for a time by the greatly enlarged and tortuous portions of the glands of pregnancy. Prominent constituents of the deciduae are the *decidual cells* that occur chiefly in the stratum compactum (Fig. 210, *A*). They are modified stromal cells which transform from the rather primitive connective tissue cells characteristic of the endometrium. The decidual cells are large, rounded elements which frequently attain a diameter of 0.04 mm. or more and may contain more than one nucleus (*B*). They sometimes show mitoses in young deciduae and this proliferation, together with their increase in size, accounts for the thickness of the gravid endometrium. As a result, the mucosa is thrown into folds and this is a characteristic feature of young pregnancies; in fact, the implanted embryo is often located on the sloping surface of a fold. The decidual cells are epithelioid in appearance and contain glycogen. Although characteristic of pregnancy their full significance is not understood. The decidual cells serve as nourishment for the early embryo, possibly act as a defense barrier against the erosive action of the trophoblast in the placental area, and help prevent excessive hemorrhage from opened blood vessels in that location.[21] They become smaller during the later months and many degenerate.

what later, the capsularis degenerates and disappears; this then allows the chorion, which is just beneath, to become adherent to the decidua parietalis for the remainder of pregnancy (Fig. 210). At term the joint thickness of these membranes is 2 mm. or less.

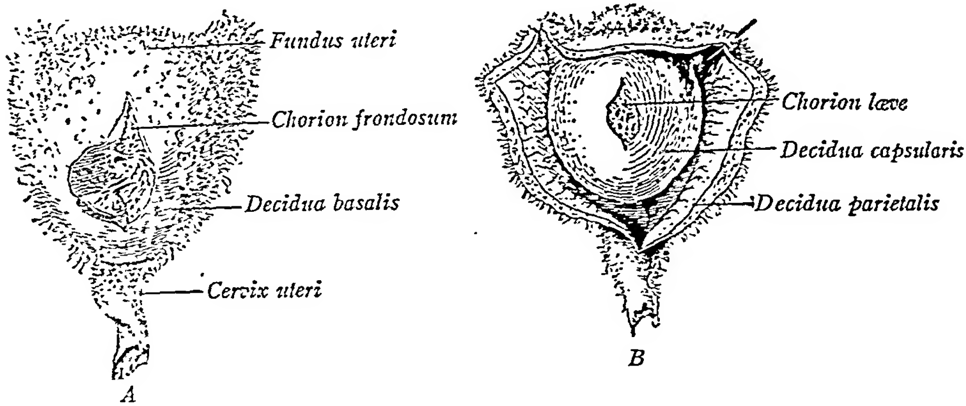

Fig. 211.—An aborted young human embryo enclosed within the cast-off lining of the entire uterus. (After Corning, from Coste.) *A*, The decidua basalis has been slit to demonstrate its placental union with chorionic villi; *B*, the opened decidua parietalis exposes the decidua capsularis which in turn has been cut through to disclose the chorion laeve.

The Decidua Basalis.—At the site of implantation the ovum lies upon a deeper part of the compact layer beneath which is the spongiosa (Fig. 193, *C*).

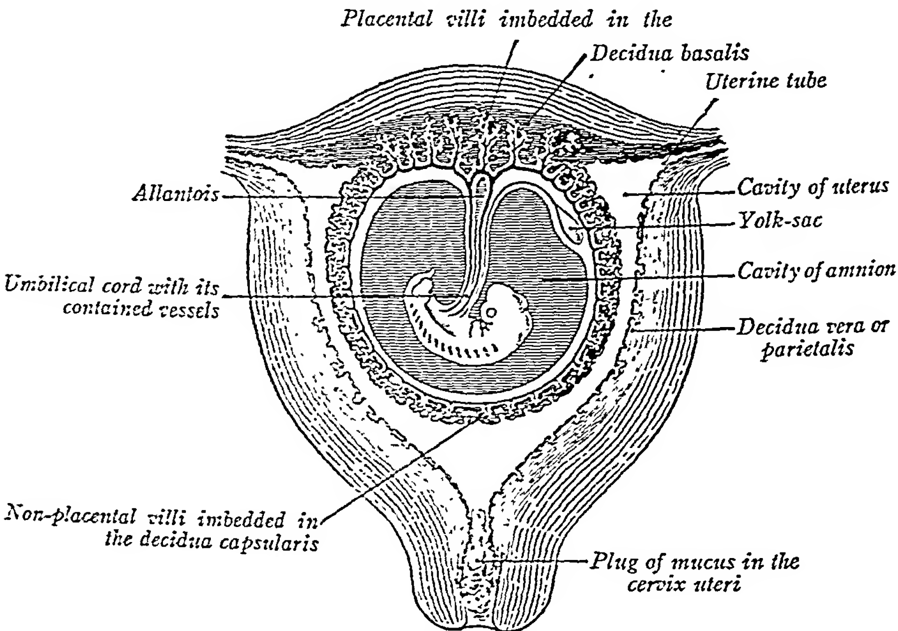

Fig. 212.—Sectional plan of the gravid uterus at three months. (After Wagner.)

These two endometrial components become the *decidua basalis* (once called the decidua serotina) (Figs. 209 and 212). During the first four months of

month that enough of these villi atrophy and disappear to leave a perceptibly bare surface, called the *chorion laeve* (*i. e.*, smooth chorion), while at four months about half of the chorion is naked (Fig. 213, *B*).[2] The villi adjacent to the decidua basalis, on the other hand, persist as the *chorion frondosum* (*i. e.*, bushy chorion) and constitute most of the fetal part of the placenta (Fig. 212); the area of persistent villi is normally somewhat circular in form, so the human placenta naturally takes the shape of a rounded disk (Fig. 214). Since the umbilical cord passes from the embryo to the frondose portion of the chorion, when this latter region becomes a part of the placenta the cord then of necessity attaches to its fetal side, usually near the midpoint (Fig. 221, *A*).

No adequate conception of the placenta is possible without the clear recognition of its double origin: the chorion frondosum (both the membrane and its villi) is the fetal portion, and the decidua basalis (*i. e.*, mostly the remains of the eroded and altered stratum compactum) is the maternal contribution (Fig. 209). In the paragraphs which follow, these components will be described more fully.

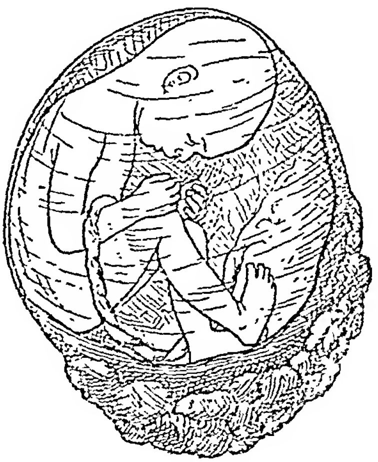

Fig. 214.—Aborted fetus of seven months within intact membranes (× 1/5). The cotyledonary placental area is below. (Arey, 'Developmental Anatomy.')

The Placenta Fetalis.—The early *true villi* of the chorion frondosum are compact, bush-like tufts with but few branches, and these are short and plump (Fig. 213, *C*). Their main stems arise from the chorionic membrane and almost all of the ends are affixed to the exposed surface of the compact decidua basalis (Figs. 198 and 215). During the middle and later months of pregnancy the villi become much more tree-like, arborizing profusely and with longer and slenderer branches. From these changing characteristics definite conclusions as to the age of a specimen can be drawn by an experienced observer.[25] All the villi are contained within the huge, open 'blood' sinus and in the older villous trees there are many floating *free villi* (*i. e.*, branches which dangle freely in the fluid content of the sinus) in contrast to the relatively few *anchoring villi* still attached to the decidual wall (Fig. 218).

All parts of the villous tree have the same structural plan (Fig. 216). At the center is a supporting connective-tissue core, which also contains cells like lymphocytes and special large cells (of Hofbauer) apparently phagocytic in function.[26] Embedded in this tissue are commonly two arterial and two somewhat larger venous blood vessels (branches of the umbilical, or allantoic vessels); these terminate in enlarged capillaries which communicate, especially at the villous tips, and constitute a continuous closed circulation. In older villi the capillaries may come to lie directly beneath the surface epithelium which is here locally thinned.[27] Originally the epithelium of the primitive chorion was a simple layer of trophoblast, but even from their first appearance the true villi have a double covering (Fig. 216, *A*). Inside,

bluish-pink lines. In the multipara the older striae have a silvery appearance, whereas the newer ones are similar to those seen in the primipara (Fig. 321).

According to Sellheim, the formation of these striae is due less to passive stretching than to the fact that the skin cannot accommodate itself to hypertrophic changes which occur in the abdominal walls under the influence of pregnancy. Williams states such contentions are supported by the fact that striae do not occur to such a marked degree in cases of ascites or tumor formation.

Appetite.—Many women have marked variations in their appetites during pregnancy, particularly exhibiting a strong desire for rather unusual types of food. The extreme conditions that may exist in pregnancy are illustrated by the experience of Williams with two of his patients, one of whom subsisted almost exclusively on deviled crabs throughout pregnancy, and the other could retain nothing but broiled lobster and Bass's ale during the first few months.

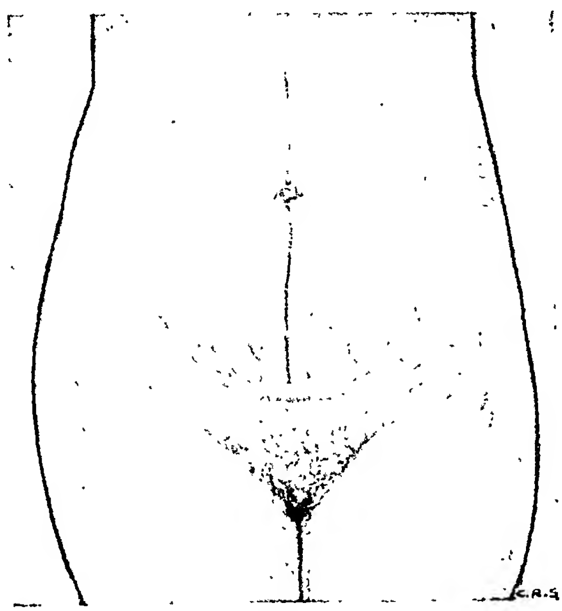

Fig. 321.—Striae gravidarum.

Mental State.—Williams also tells us of mental and emotional changes which sometimes characterize pregnancy. Occasionally women are seen who diagnose their condition chiefly from the changes in their temperaments. It is well known that pregnant women are subject to varying moods. They become hyperexcitable and have very marked changes in character, so that a quiet even-tempered individual may become complaining and irritable. DeLee states that in olden times pregnant women were considered normally irresponsible. They are not reliable as witnesses, perception being not so acute. Hysterical women suffer exaggerations of their symptoms, marked hysteria sometimes occurring. DeLee mentions that he has found many interesting phenomena in studying these cases psychologically. He thinks that pregnancy is the most momentous thing in a woman's life and her mental adjustments, happy or unhappy, to the new condition will determine her health, spiritual as well as physical. In the majority of cases the patient

plate. Closer analysis shows that two different kinds of elevation are represented.[2] Those of the early months are so-called *decidual pillars* which represent portions of the compact decidua spared from erosion during the formative period of the placenta. As a consequence, they are irregular in distribution and relatively short; they are not seen beyond the middle of pregnancy. In the later months larger *placental septa* are brought into existence (Fig. 218), presumably by the faster rate of horizontal growth of the uterine wall in comparison to the chorionic membrane. This results in the production of decidual folds between the rapidly enlarging villous trees. The placental septa, therefore, mark off the *cotyledons*, some fifteen to twenty in number, and incompletely separate them. Each cotyledon is a natural

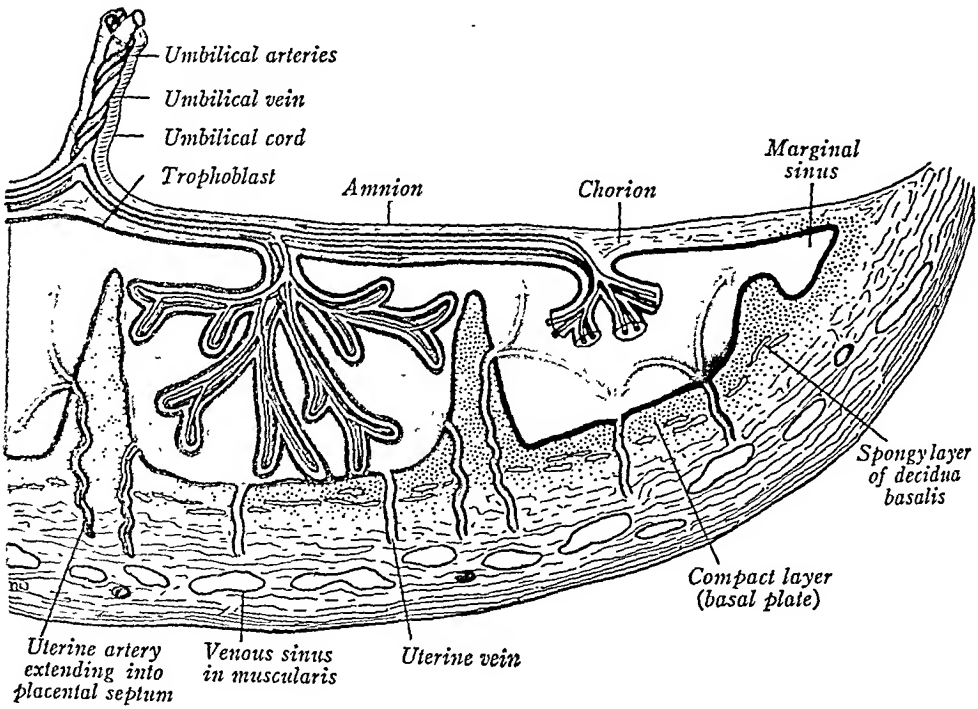

Fig. 218.—Diagrammatic vertical section through one half of a human placenta *in situ* to demonstrate the scheme of circulation. Only one chorionic villus and the stump of another are shown extending into the intervillous spaces of cotyledons. (Arey, 'Developmental Anatomy.')

unit, since it contains a main villous tree which distributes its smaller branches and twigs throughout the cotyledonary area (Fig. 218).

The uterine arteries and veins pass through the basal plate obliquely, losing their accessory coats as they proceed. The arteries course spirally and were formerly believed to open on or near the septa while the veins were held to arise more centrally in the cotyledons (Fig. 218). Such an arrangement might be thought to favor somewhat the effective intervillous circulation of blood. However, this anatomical arrangement is no longer credited, and even the existence of arteries opening into the placental sinus is a matter of doubt, as will be discussed presently. As the placenta increases in size the vessels grow larger; the floating ends of free villi are fre-

The Mature Placenta.—Both the uterus and the placenta continue to enlarge with the growth of the fetus. At the third week the placenta occupies one-fifteenth of the internal uterine surface, and by the end of the second month its area is nearly one-third that of the uterus. By the fifth month it comprises one-half the total area, after which there is a relative loss (Fig. 214) until at birth the placenta again covers not more than one-third of the greatly dilated uterus (Fig. 217, A). During the first five months there is continued absolute growth both in area and in thickness, while in the last five months the diameter remains practically unchanged but the placenta thickens threefold to fourfold and gains a much sharper margin. Increase in

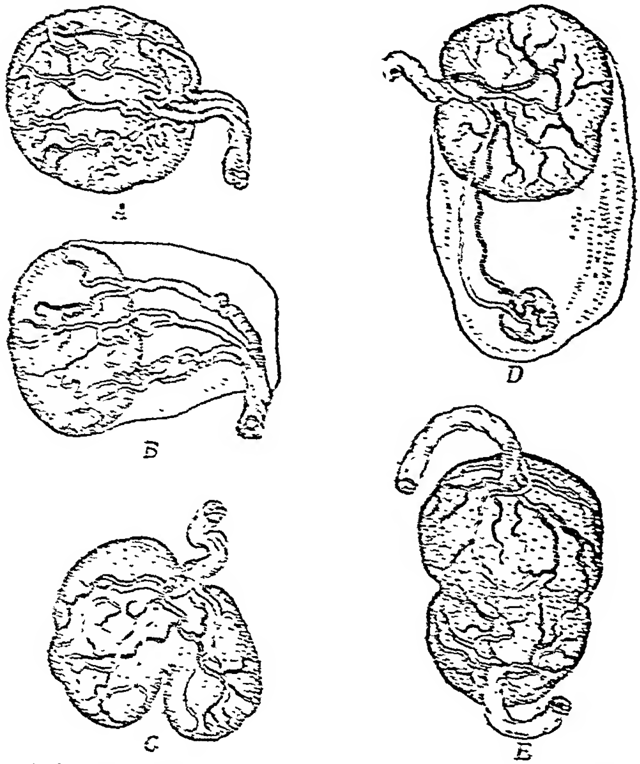

Fig. 220.—A, Marginal insertion of the umbilical cord on the placenta. B, Velamentous attachment of the cord on membranes adjoining the placenta. C, Bilobed placenta. D, Main and accessory placenta. E, Fused, twin placentas. (Arey, 'Developmental Anatomy.')

thickness results chiefly from the elongation of the chorionic villi. Increase in area involves centrifugal trophoblastic activity and a splitting of the marginal decidua as the placenta spreads, but the precise method and details of such growth are not well understood.[3]

The mature placenta makes a prominent patch upon the interior of the uterus. While still in place it is convex on the uterine surface and concave on the fetal side (Fig. 219), but after its expulsion at birth the placenta everts and these relations are reversed. The expelled placenta is typically a thick, circular disk which averages seven inches in diameter, one inch in thickness, and weighs a little over one pound. Departure from the typical shape of the

of two plates (Fig. 217, *B*), the chorion and the decidua basalis, between which is the labyrinth of chorionic villi and intervillous spaces already discussed. On gross section the fresh placenta is dark red and spongy.

The mature placenta shows various indications of degenerative changes, and some claim that at term the placenta is nearing the end of its functional capacity both because of these alterations and because the trophoblast has lived out its normal life span.[?] The increasing occurrence of fibrinoid substance in older specimens has been mentioned (p. 468): its presence on villi decreases their absorptive surface and when aggregated constitutes *white infarcts*. Furthermore, cysts occur regularly in the chorionic tissue. *Red infarcts*, caused by massive coagulation of blood in the intervillous spaces, also are characteristic.

Physiology of the Placenta.—The blood of the mother and that of the fetus circulate in totally independent and separate channels (Fig. 218). The relation of the chorionic villi and its vessels to the maternal blood which bathes the villi is much like that of the blood vessels of the hand to the water in a tub when the arm is immersed. A more precise comparison is furnished by the intestinal villi in contact with the fluid content of the gut cavity during digestion. In the case of both chorionic and intestinal villi there is no direct contact or mixture between the external fluid and the blood of the villi, but their only communication is through diffusive interchange.

In the placenta the trophoblastic covering of the villus, the endothelium of its capillaries and (except for some special thinner regions)[?] the connective tissue stroma all intervene to separate the fetal and maternal blood streams (Fig. 216). Nutritive substances (proteins, fats, and carbohydrates), inorganic salts, iron, and oxygen in solution pass from the mother's blood to the fetus, whereas waste products of fetal metabolism are transferred in the reverse direction. On the whole, these interchanges appear to be the result of physical diffusion,[?] but there are indications of the placental tissue controlling the passage of some fluid constituents in a secretory or special absorptive manner. For a long period the mother digests and prepares food for the embryo, supplies oxygen, excretes its wastes and controls the temperature. Toward the end of gestation the fetus begins to perform vital functions, such as the elaboration of glandular secretions and the excretion of urine, in preparation for the suddenly changed conditions at birth.

The total absorbing surface of the chorion frondosum is calculated at 70 square feet.[31] By comparison, the skin area of an adult is less than one-fourth this amount but the respiratory area of the lungs of a newborn is some two or three times as great. The smaller absorbing surface and the sluggish 'circulation' of the placenta are responsible for the very low oxygen content of fetal blood: this is balanced by the relatively large amount of blood in a fetus, its rapid circulation, and the low oxygen requirements due to bodily quiescence and the non-necessity of a fetus producing its own heat.[?] Among the placental activities, on which there is as yet no complete agreement, should be mentioned the presence and possible local elaboration of hormones and the presence of various enzymes for the splitting of proteins, fats, and carbohydrates to be used for fetal nourishment.

Parturition.—From the beginning of pregnancy the uterus enlarges to keep pace with the growth of the fetus. The muscular coat increases some twenty-four fold, chiefly through individual enlargement of the smooth-muscle

the placenta which cause it to lift and separate, whereupon the pull of the placenta progressively detaches the other deciduae (Fig. 222). The plane of separation of all these membranes lies usually in the spongy layer where there are only thin-walled partitions between the stretched glands (Figs. 210, *A*, and 217). Following the birth of the child there enters a second series of uterine contractions, the 'after-pains.' Through them the placenta and its associated membranes (the 'after-birth') are forced out. This leaves the uterine surface rough, due to the uneven separation of the deciduae and the resulting adherence of shreds of spongiosa tissue together with ruptured uterine vessels. Contraction of the uterine muscles diminishes the size of the ruptured blood vessels and so prevents extensive hemorrhage. The restoration and repair of the uterus proceeds rapidly, and from the thin remnant of the spongy layer are regenerated the tunica propria, glands and surface epithelium. For several weeks there is a discharge (the '*lochia*') of fluid containing blood, shreds of sloughed tissue, and leukocytes.

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tissue and, indeed, he felt that the amnion may be regarded as a second line of defense between mother and child, serving to protect the latter from substances in the maternal circulation that may be deleterious to so delicate an organism. Taussig[6] holds that from the histopathology of the amnion and from these biochemical studies there can be no reasonable doubt that the source of the amniotic fluid is the amnion itself. It is probable that a slight admixture with fetal urine may occur shortly before or during labor, but this source of fluid is inconsiderable and has no functional significance.

An irrelevant but important clinical point in connection with the liquor amnii is embodied in a recent observation of Giordanengo,[7] who investigated the action of this fluid in relation to the formation of postoperative peritoneal adhesions. Fifteen cc. of liquor amnii was injected into the peritoneal cavity of rabbits. It was found that this fluid is not capable of stimulating or preventing proteolysis *in vitro* nor of provoking in the peritoneum inflammatory plastic reactions, but does produce merely a hyperthermia and hyperleukocytosis of a transitory nature. This rather refutes the common view that, in the performance of cesarean section, spilling of amniotic fluid into the abdominal cavity provokes subsequent peritoneal adhesion.

Polyhydramnios, hydramnion or hydramnios is the condition in which an excessive quantity of liquor amnii collects within the membranes. Minor degrees of hydramnion are fairly common but occasionally huge accumulations of fluid occur, Kustner having observed fifteen liters and Schneider thirty liters, at the fifth and sixth month, respectively.

The factors influencing the quantitative and qualitative production of liquor amnii are almost unknown. As Taussig well says, there may be either an excessive production or an excessive retention of fluid. Careful examination of the amniotic epithelium has disclosed no variation from the normal in the histology of the cells in cases of hydramnion. Schmidt[8] believes that lessened absorption is a most important factor, the greater part of such absorption taking place in the alimentary tract of the fetus after the liquor has been swallowed. In many cases of hydramnion there has existed an absence of such absorption due to atresias of the upper alimentary tract.

Etiology.—The etiology of hydramnion may be briefly considered under several groupings. The first great causative factor is deformity of the fetus. According to Hinselmann[9] fetal deformities can be grouped into: (1) those having no influence upon the amount of amniotic fluid, as hydrocephalus; (2) those producing an excess of fluid, due either to increased transudation of fluid or deficient swallowing and absorption, as anencephalus, atresia of esophagus, etc., and (3) those associated with oligohydramnious or scanty fluid. The second etiologic cause is multiple pregnancy, especially uniovular twins, in one of which ova hydramnion is quite frequent.

Third in etiologic significance is the occurrence of moderate degrees of hydramnion in excessively large children and placentae. In one of the writers cases a child weighing 10 pounds, 4 ounces was associated with 3000 cc. of fluid.

Maternal toxemia is another prolific source of hydramnion, especially where there is an associated edema.

Syphilis has been regarded as causative but there seems little evidence to support this contention. In most case series the percentage of syphilis is no greater than in other groups of pregnant women.

made to determine the nature of such deformity if present. Here the *x*-ray is of prime importance and repeated roentgenological examination should be undertaken, if necessary to secure a clear understanding of the fetal contours.

Beck[10] reports a highly instructive case wherein a woman in the twenty-ninth week of her third pregnancy (the previous children both perfectly normal, having been born at term) developed a large hydramnion, giving rise to pressure symptoms and obscuring the auscultation of the fetal heart and the appreciation of fetal movements. *x*-Ray examination revealed a fetus with a relatively small head. Diagnosis of hemicrania was made. The membranes were ruptured and an anencephalic monster was delivered spontaneously after the expulsion of about eight liters of amniotic fluid. The patient was thus spared considerable suffering and delay and saved from the danger of continuing distention of the uterus.

General treatment consists of rest in bed to avoid undue cardiac strain and careful search for possible toxic factors such as nephritis. Should the pressure symptoms become extreme, the excess fluid should be drained away by a trocar introduced through the cervical canal. The withdrawal should be slowly done to prevent too great fluctuation in the intra-abdominal pressure. Rigid asepsis must be practised. The evacuation is probably best accomplished with the patient in the knee-chest position to avoid prolapse of the cord and the too sudden descent of the head into the lower uterine segment. This procedure is usually followed by the onset of labor in a few hours, in which event preparation must be made to combat possible postpartum hemorrhage which is all too common a sequel.

The presence of a monster as proved by the *x*-ray is an indication for immediate evacuation of the fluid and induction of labor at any period of pregnancy.

Oligohydramnion.—This term implies a deficiency or absence of amniotic fluid and is far less common than the excess previously described. The liquor amnii may be represented by a few drachms of thick, viscid, greenish or brownish fluid, often having an offensive and somewhat characteristic odor.

The *etiology* is shrouded in mystery, but it is suggested that urinary deformities in the fetus are present in a large number of the cases. Thus Neumann[11] found such deformities to occur in 9 cases among a total of 49.

Oligohydramnion occurring early in pregnancy is attended by serious consequences to the fetus, by reason of adhesions forming between it and the amnion with which it lies in contact. Cranioschisis, gastroschisis, spina bifida, and amputation of extremities, curvatures, clubfoot and skin defects have all been reported. When the diminution in fluid takes place late in pregnancy, the effect upon the fetus is less marked but still severe. Under such circumstances, the fetus clearly shows the effect of long-continued pressure, and minor deformities are usual. Especially characteristic is the dry, leathery skin which may be a result of the oligohydramnion, but which Ahlfeld believed to be causative.

The *diagnosis* is difficult unless the uterus, smaller than normal, may be easily palpated through a thin, relaxed, abdominal wall as irregular in outline and coapted closely to the fetal body.

Taussig (*q.v.*) well sums up the *clinical characteristics* of oligohydramnion as follows:

1. Proportionately small size of pregnant uterus.

minute to several centimeters in diameter. These nodules are the so-called "infarcts" or, as they have been variously termed, "hepatization," "scirrhus," "placentitis," "apoplexy," "cirrhosis," and "phthisis."

Several *varieties* have been described and their mode of origin has given rise to a huge literature, out of all proportion to their clinical significance. J. W. Williams described six kinds of infarcts, and the number has been raised or lowered by other observers. The whole subject has been materially clarified by the excellent paper of Siddall and Hartman[17] which is freely quoted here. Failing to find satisfactory names for the special forms of infarcts, these writers have divided them into four groups by number as follows:

1. Infarcts of the first type are poorly defined, or even very irregular, pearl-gray formations occurring usually in the depths of the placenta but at times also near the surfaces and margins. They may vary from a few millimeters to several centimeters in width and occasionally are so large as to extend from surface to surface. We have never seen massive involvement

Fig. 223.—Placenta from abortion at the fourth lunar month, showing an early infarct of the first type. (Siddall and Hartman in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

as sometimes occurs in the last type. There are no striations, but there is often a mottled appearance near the outside due to the partial inclusion of small areas of normal placental tissue (Fig. 223).

Microscopical examination of an advanced infarct of this kind shows that at the edges there are broad projections of fibrin extending outward to outlying and nearly normal villi, while toward the center the structure becomes solid and consists more and more of degenerated shadows of villi surrounded by old fibrin, fragments of nuclei alone suggesting the original cellular structure. Evidently, the deeper portions are distinctly older, and examples are easily found showing development by peripheral involvement of villi with fibrin projections from a nucleus of several villi matted together by fibrin.

2. Sharply demarcated, usually rounded or oval bodies, occasionally roughly quadrilateral, varying in diameter from a few millimeters to several centimeters and in color from red, brown, or almost black to pink or brick

upon the villi with localized epithelial defects and is aided by the slowness of the blood stream in the maternal circulation.

Paddock and Greer[19] feel that the small placental cysts present in practically all placentae and having their origin in the decidual septa or so-called "decidual islands" are formed by action of trophoblastic cells on decidual tissue. They believe that these cysts are always associated with some degree of white infarction and are in all probability the cause of the white infarcts with which they are associated.

The types 2 and 3 of Siddall and Hartman while differing greatly in appearance from the white infarcts just described, probably all represent different phases of the same anatomical change. Probably they are formed by rapid coagulations of blood in layers against older degenerated areas, normal villi being pushed back as the masses increase in size.

The infarcts of type 4 are probably examples of true infarct formation in the ordinary sense, being due to a disturbance of the fetal maternal circulation.

The *frequency* of infarct formation is noteworthy, since in Siddall and Hartman series of 700 placentas there were 67.7 per cent presenting infarcts of some kind, measuring at least 5 mm. in diameter, and it is probable that many more showed these defects of microscopical dimensions.

Thoms,[20] who studied 58 placentas by injection, section and roentgen photographs, says that marginal white infarct formation is so common that it may be considered a normal phenomenon of the mature placenta.

Clinical Significance of Placental Infarcts.—The older writers laid great stress upon the interference with fetal oxygenation which might be produced by extensive infarct formation and cases are recorded wherein the death of child *in utero* was presumably caused by such diminution in oxygenative surface (Fig. 227).

In Thoms' series, however, 17 per cent were found infarcted to a degree which actually interfered with the placental circulation. In one case 24 per cent of the placental circulation was thus arrested by the process, yet there was no evidence of maternal toxemia or ill effect upon the baby; and the conclusion is identical with that of Siddall and Hartman from their much longer series. Furthermore, infarct formation seems to bear no relation to the growth and weight of the child as shown by several series of statistics.

The writer has long felt that the tremendous factor of safety provided for by nature in all of her processes must and does apply to the placenta, and that all possible contingencies are so provided for short of complete catastrophic breakdown, as, for example, abruptio placenta.

The Relationship of Infarction and the Toxemias of Pregnancy.—Here lies a fruitful ground for argument among obstetricians. Most text-books emphasize the relationship. For example DeLee[21] says that infarcts cannot be diagnosed clinically but their existence can be expected in cases of nephritis, heart disease, syphilis, endometritis and when they were present in previous pregnancies. In Siddall and Hartman's series there was some increase in the size and number of the infarcts in toxic cases, but these authors believe with Young, that such higher incidence is a consequence of the toxemia rather than the cause, and results from an intervillous stasis following upon the more marked changes in the uterine vessels.

In Thoms' small series there was no definite relationship and as this

occupy the center of an infarct, are filled with gummy fluid and according to J. W. Williams were mistaken by the older writers for abscesses.

Placental cysts have been carefully studied by Paddock and Greer[19] and these observers describe a typical microscopical portion as follows:

"Projecting into or surrounded by the villous tissue of the placenta is seen an area of tissue markedly different in appearance. Separating this area from the surrounding villi is a pink staining band of canalized fibrin, identical with the Nitabuch's fibrin layer at the junction between the fetal and maternal tissue. This fibrin layer may extend outward and surround adjacent villi and decidual tissue with the concurrent picture of white infarction (Fig. 228).

Fig. 228.—Cross section through the placenta showing a large cystic structure filled with gelatinous material and well circumscribed. Lower surface, fetal surface; maternal surface above. Enlarged one and a half times. (Courtesy of Drs. McNalley and Dieckmann.)

"Internal to the outer fibrinous band is usually a thicker layer of degenerating tissue, to be identified in most cases as degenerative decidual material.

"Internal to this decidual tissue and invading it is found another type of cell, large, deep staining, epithelioid in appearance, and apparently of trophoblastic origin. This type is probably identical with Langhans' cells. The cystic cavity is filled with the material before described, which from its staining properties seems to be true colloid. These cells are apparently quite invasive inasmuch as whenever they appear, there is adjacent tissue destruction. It appears that these cells start at some region in the decidual septa,

"The villi of the adjacent placental tissue have occasionally been found normal: but more frequently, and especially in the case of the larger tumors, they have degenerated under pressure. Usually there is a layer of compressed villi and fibrin next to the tumor, thus giving rise to a sort of pseudocapsule

Fig. 229.—Cross section of placenta and tumor. (Siddall in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

which resembles the ordinary white infarct in structure. Between this and normal placental tissue there may be a region in which the villi, with distended and tortuous vessels, are plastered together by fibrin. There seems to be no relation between the occurrence of placental tissues and age or parity.

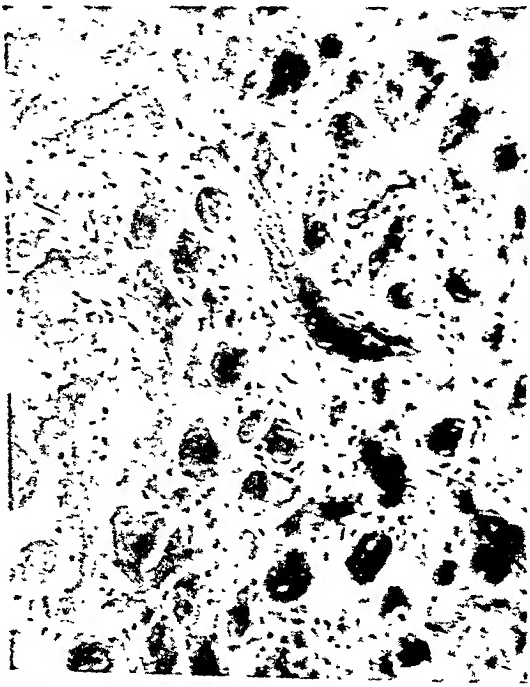

Fig. 230.—Angiomatous part of the tumor. (Siddall in Amer. Jour. of Obst. and Gyn., C. V. Mosby Co., Publishers.)

The tumors are benign having no tendency to reproduce themselves or to metastasize" (Fig. 230).

Clinical Aspects of Placental Tumors.—These growths seem to have little or no effect upon the prognosis or course of pregnancy in the mother. Among the 131 cases collected by Siddall, the obstetrical history was about as usual

Changes in Cervix.—The cervix increases in size during pregnancy as a result of hypertrophy of the muscle fibers, just as does the body of the uterus. There is an early edema and loosening of the connective tissue, which causes the softening of the cervix. As a result of the activity of the cervical glands, there is a marked amount of mucus produced which first appears in the canal, causing complete stenosis. Williams states that prior to 1927, the only marked change in the cervix that was usually mentioned was the softening. He also states that the cervical mucosa undergoes such marked proliferation that at the end of pregnancy it occupies half of the entire cervix instead of a small fraction as at other times. A honeycomb-like structure develops, the meshes of which are filled with tenacious mucus.

Braxton-Hicks Sign.—Intermittent contractions of the uterus were first described by Braxton-Hicks in 1872. Williams remarks that although all these contractions are quite characteristic and more readily elicited during pregnancy, it has been shown by Sun, in his clinic, that the human uterus, whether pregnant or not, is constantly undergoing contractions. These movements have also been observed in cases of hematometria as well as in cases of soft myomata of the uterus. Contractions occur at very irregular intervals, the frequency varying with the individual case. Sometimes they occur only once in a few days and at others they can become so marked that they simulate the contractions of early labor. In some multiparae, the contractions are very frequent and quite marked, so that they become more or less annoying to the patient and make her rather uneasy as regards whether she actually is in labor or not. In some multiparae these contractions become so marked that they cause the patient a considerable amount of discomfort during the latter months of pregnancy.

Fetal Heart Beat.—From the fetus, one hears the heart beat (fetal pulse). Bumm tells us that M. Major, a surgeon of Geneva, first emphasized this as an unmistakable sign in 1818. Independently, Lejuneau de Kergeradek, through a contribution at the Academie de Medecin in 1822, also reported the importance of the fetal heart beat as a positive sign of pregnancy.

At about sixteen to twenty weeks, the fetal heart beat can be heard through the abdominal wall as a simple systolic tone, and later as a double tone similar to the tone of the adult heart. Experienced observers, as Sarwey has shown, with repeated examinations have demonstrated the sounds as early as the twelfth week. The frequency of the fetal heart beat is between 120 and 160, with an average of about 140 per minute. It rises with the movements of the fetus and drops during the uterine contractions. Like all phenomena of sound, the heart sounds are transmitted better through the tissues than through fluid. Therefore, the heart sounds are heard best where the fetus lies closest to the uterine wall. At such places where there is a layer of amniotic fluid between the fetus and the uterine wall, the sounds are only heard weakly and if the amount of amniotic fluid is considerable and surrounds the fetus on all sides, it may hinder the perception of the fetal sounds entirely. In certain areas the intensity of the tone increases with the nearness of the fetal heart; accordingly, one may determine the place where the fetal heart sound is heard loudest for all fetal attitudes. With the typical flexion of the fetal body, the back approaches the uterine wall more closely. The heart sounds are heard through the back of the fetus, but they are heard loudest through the anterior portion of the chest because of the close proxim-

far as known are never primary but originate as metastases from a remote primary tumor focus.

Senge[26] described a carcinoma of the placenta which he considered to be a metastasis from a carcinoma of the stomach. Several similar cases have been recorded.

Walz[27] reported multiple tumors of the placenta, typical of myxosarcoma and which he regarded as metastases from a similar tumor in the leg, which had originated during pregnancy. In this connection Williams[28] remarks that the observations are of great interest in that they forcibly illustrate the connections of the intervillous spaces with the general maternal circulation.

Inflammation of the Placenta.—Acute inflammation of the placenta is occasionally noted but is never primary, being due to an extension from the decidua, resulting from an exacerbation of a preexisting chronic gonorrhea or from an acute infection due to the entrance of pyogenic bacteria into the oval sac. Such inflammatory change almost always accompanies general uterine sepsis or is a result of prolonged labor or, frequently, of premature rupture of the membranes.

Very rarely abscesses are found in the placenta, following prepartum infection.

Tuberculosis of the Placenta.—For a detailed discussion of obstetrical tuberculosis, the reader is referred to Chapter XXIX.

Placental tuberculosis offers great difficulty in demonstration, for neither microscopical nor histologic changes need be present even though the tubercle bacilli may be numerous.

According to Norris[29] tuberculosis apparently exerts no influence upon the size of the organ, nearly all of the described specimens being of average size and weight. When massive lesions do occur they are usually found as yellowish, soft, caseous areas, at the base of the placenta, near the insertion of the cord. The maternal and fetal surfaces are often rougher than usual, and occasionally small tubercles may be present. The cord is generally normal.

Warthin[30] divides placental tuberculosis into five groups: (1) decidual; (2) intervillous; (3) intravillous; (4) intravascular chorionic, and (5) chorioamniotic.

Decidual and Intervillous Tuberculosis.—The first is the most common and is most frequently found in full-term placentae. The second or intervillous variety is also frequent. According to Warthin, there are, throughout the intervillous spaces, small round, deeply staining areas composed of firmly granular or hyaline substances, containing lymphocytes and polymorphonuclear leukocytes in varying stages of disintegration. The majority of these areas are about pin-head size or somewhat smaller and in general resemble the hyaline thrombi of the decidual vessels. Varying numbers of tubercle bacilli are present, some in the thrombi as well as a few in the intervillous blood spaces. In some instances epithelioid cells and typical Langhans' giant cells are present, extending from the stroma of the villus into the thrombi.

Intravillous Tuberculosis.—This type is less common, but quite frequently seen. Here tubercles are present in the stroma of villi where syncytium is normal and independent of intervillous thrombi. The lesions present all the characteristics of tubercles, and giant cells may be present in various stages from the first localized necrosis to advanced caseation. Warthin remarks

Occasionally hemorrhages take place in the decidual septa between the cotyledons and also in infarcts both red and white. DeLee gives the causes of placental hemorrhage as acute and chronic congestion, increased blood pressure, stagnation of the venous blood current, disease of the villi, or of the decidual blood vessels, the blood changes incident to nephritis, toxemia, hemorrhagic diathesis and syphilis, physical or mental shock and local injury. The writer is inclined to place syphilis first on the list (Fig. 235).

Clinically, placental hemorrhages are of great importance. If they develop early in pregnancy, abortion is the rule, while if the hemorrhage be not sufficiently massive to cause this result, arrest of fetal development may take place with resultant monster formation.

Later in pregnancy massive serotinal hemorrhages are the first phase of abruptio placenta, and should the bleeding be between the cotyledons or in the subchorial decidua, serious results to the child may be anticipated, as from hypo-oxygenation and insufficient nutrition.

An extraordinary case of rupture of a varicosity in the placenta, causing the death of the fetus, is reported by Leff. In this case the patient was proceeding normally with a multiparous labor when she suddenly experienced a gush of blood from the vagina, after which the fetal heart sounds and movements disappeared. The woman gave no evidence of blood loss, there were no signs of placenta praevia or abruptio placentae and labor terminated spontaneously with the delivery of a dead fetus. On close examination of the placenta and injection of the umbilical vein with water, a rupture was disclosed in a vein on the fetal surface, 3 cm. from the periphery of the placenta and about 2 mm. in diameter (Fig. 236). The bleeding was entirely fetal, there being no maternal blood loss.

Leff quotes Rannenberg as reporting the only similar case in the literature. (Amer. Jour. Obstet., 31, xvii, 11.)

Edema of the Placenta.—Huge edema sometimes occurs in the placenta, and is in most instances associated with hydrops universalis fetus. The writer (Schumann) collected 38 cases of this condition among which the placenta was described in 36, 30 of these revealing massive edema. In Opitz' case the placenta weighed 2280 Gm. The condition is usually present in women who have shown the existence of some form of gestational toxemia, or in whom the presence of such toxic factor is suspected but cannot be confirmed. Syphilis is rarely causative. On examination such placentae usually show great edema with some degeneration of the syncytial cells. The villi are vacuolated, there is separation of the connective tissue by edema and the syncytial cells are swollen, their nuclei pale and in many instances shrunken.

Clinically, if the edema occurs early in pregnancy, abortion promptly follows. Should the gestation continue, the child usually suffers from general edema, and formidable dystocia may result from this cause.

Calcification of the Placenta.—Small calcareous deposits or flat plaques are frequently found on the maternal surface of the placenta. They are composed of calcium carbonate, calcium phosphate, and magnesium phosphate, and are usually seen in the upper layers of the decidua serotina, especially around the anchoring villi, and are due to the calcareous degeneration of the villi, being in a sense analogous to infarcts. They are probably a phase of senescence of the placenta and have no clinical significance, there

but ovulation may occur rather late, between the fifteenth and the thirtieth day.

Newell and Allen recently devised a method of recovering the extruded ovum from the tube, studying the question of polar body formation and also the condition of the corpus luteum. They felt from the condition of the ovum and the character of the corpus luteum, which were removed at operation, that ovulation takes place on the fourteenth day of the cycle. In reviewing this subject, Kehrer believes that the physiologic period is about a week and that the fifteenth day of the cycle may be considered the most frequent. He also calls attention to the fact that in a twenty-one-day cycle, the average time for ovulation is about the tenth to the twelfth day after the first day of menstruation.

(*b*) The time it takes the extruded ovum to reach the fallopian tube is not definitely known. It is, however, dependent on two functions of the tube, first the action of the cilia and second the peristalic waves. Obviously, the ovum will travel faster through the wider ampulla than through the narrow isthmus. This has been demonstrated in animals. It has been well established in animals that the ovum gets into the tube shortly after expulsion, in guinea-pigs in less than twenty-four hours, in most species from two to three days. In dogs it has been shown about as long as ten days. Grosser and Ruge feel that the human egg can live in the tube several days and still become impregnated. From the study of Newell and Allen, five ova were recovered in the tube between the twelfth and fifteenth days. Three showed formation of the first polar body, and one definite formation of the second polar body. The finding of so-called *cell balls* in the tube after this length of time would indicate that tubal ova probably degenerate by the twenty-first day of the menstrual cycle and are probably incapable of being fertilized in most instances after that time.

(*c*) For the discussion of the duration of pregnancy, information concerning the migration time and the life period of the spermatozoa is of importance. The spermatozoa in the vagina in physiologic conditions are subject to a more or less acid reaction, and then in the cervical canal they must make their way through the rather thick alkaline secretion. With the head pointed toward the tubes they reach the tube and must travel against the movements of the cilia. Experimentally, in dogs, Haussmann found spermatozoa in the tubes one hour after intercourse. In humans they can be readily demonstrated in the tubes in twenty-four to thirty-six hours. That would be the least possible time between intercourse and impregnation. The duration of life of the spermatozoa indicates that they have more vitality than the ovum.

Hoehne and Behne have established the fact that the movements of the spermatozoa are lost after one hour in the vagina, which has a markedly acid reaction, whereas in cases where the vaginal secretion is only slightly acid, they have been found as long as two days afterward. The duration of life of the spermatozoa in the tube has been rather clearly demonstrated in animals. Bischoff found spermatozoa in dogs from eight to ten days, Hensen in rabbits from four to six days. Hirshfeld, at autopsy, found them alive one to two days after intercourse. According to Hoehne and Behne, three days is the lifetime of the spermatozoa in the tube. By special technic, Nürenberger found living spermatozoa in the tube fourteen to fifteen days

processes by which this is accomplished. Immediately following the birth of the head and before the body of the child has been extruded, the uterus contracts powerfully with the exception of the placental site. After the expulsion of the fetal body this contraction is much increased until the entire musculature is retracted and much thickened, its cavity being almost completely obliterated. The organ is then practically a solid mass of muscle, in close application to the placenta which remains attached, but which owing to the diminution in its area of attachment has become much thicker than at the onset of labor.

As the uterine contraction and retraction continue a point is finally reached where the inelastic placenta can no longer accommodate itself to the reduced area of the placental site and it is accordingly peeled or squeezed off the uterine wall. This separation takes place within the decidua spongiosa, where lie

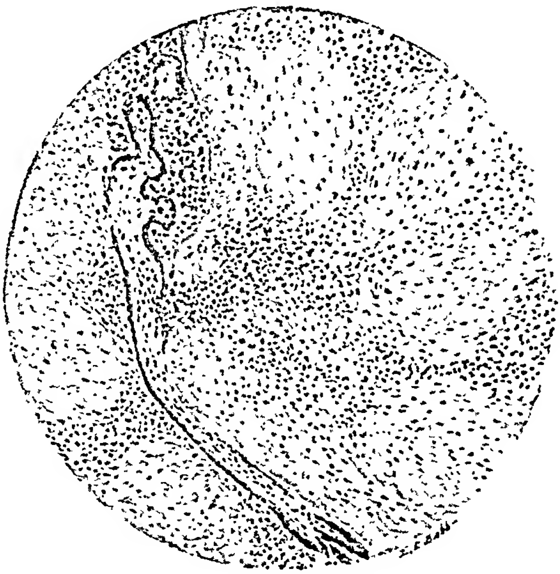

Fig. 239.—Placenta accreta. Villus penetrating muscle. (Polak and Phelan in Surg., Gyn., and Obst., February, 1924.)

the delicate trabeculae and the most dilated vessels. Following this rupture of the spongy layer there rapidly forms a retroplacental hematoma, the pressure of which further accelerates placental detachment.

This separation takes place in the spongy layer of the decidua basalis so that after expulsion there is a layer of the decidua basalis adherent to the placenta, while a portion of this structure remains attached to the uterine wall (Figs. 239, 240).

If the foregoing mechanism be assumed to be correct it will be seen that the presence of a decidua basalis is absolutely necessary to normal placental separation. In placenta accreta, where there is no such decidua present and the villi directly penetrate the uterine wall and make with it one continuous structure in which no line of cleavage can be demonstrated, the placenta cannot separate and hence remains as an integral portion of the uterine wall. Furthermore, in the absence of decidua, the chorionic villi erode

may be inferred when the placenta has been retained in the uterus for more than two hours following the delivery of the child, without uterine bleeding, descent of the cord or the rise of the globular fundus uteri.

Differentiation of simple adhesion from accreta can only be made after manual intra-uterine exploration as described above.

Prognosis.—The mortality of placenta accreta is difficult to estimate because of the imperfection of records and the rarity of the condition. Polak reported 4 cases of his own, 3 dying from hemorrhage, or sepsis after attempts at manual removal, while the fourth patient recovered after hysterectomy.

Both Nathanson and Feiner's patients recovered, the treatment having been early hysterectomy. Before these cases were reported, Polak considered that his own case and one of Greifswald were the only recoveries in the literature. The cause of death is either hemorrhage or sepsis or both. If manual removal is attempted and portions of placenta torn off, the bleeding is usually so severe as to necessitate abandonment of the attempts at

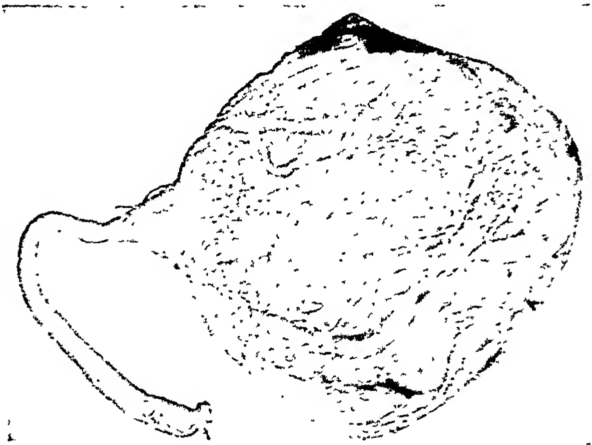

Fig. 241.—Battledore placenta.

removal, and uterine packing, which often fails to control the hemorrhage. In addition, owing to the great thinning of the uterine wall, perforation may result, with intra-abdominal bleeding as a sequel.

Sepsis, of course, is always to be dreaded and is usually associated with hemorrhage in effecting the literal termination of these cases.

Treatment.—From the foregoing description a definite management of unexpelled placenta may be formulated. Whenever the placenta remains unexpelled for two hours, in the absence of uterine bleeding and descent of the cord, the delay should be viewed with suspicion and no attempt at Credé expulsion should be made. Aseptic manual exploration of the uterine cavity under anesthesia should be made in these cases and a line of cleavage sought.

Should such cleavage be demonstrated, simple adhesion is the causative factor and the placenta may readily be peeled from its uterine attachment and extracted, the uterus being then firmly packed with gauze. Should it be impossible to detect a line of cleavage, attempts at manual removal should at once be abandoned and the patient immediately subjected to abdominal

surface or, particularly, if torn blood vessels are found at the margin of the membrane, this anomaly must be considered and manual exploration of the uterus must be performed in order to remove it.

Placenta circumvallata is a condition in which there is a more or less complete circular ring upon the fetal surface of the placenta at varying distances from its margin. The ring, about 1 cm. in width, is slightly elevated upon the general surface of the placenta, and usually presents a white or yellowish appearance. Usually the ring lies somewhat eccentrically and divides the fetal surface of the placenta into two distinct regions, the central portion bounded by the internal margin of the ring, and a peripheral zone outside the ring. The central area is that of a normal placenta containing the attachment of the cord and the large fetal vessels, which latter are always absent from the peripheral portion of the placenta, their terminal branches

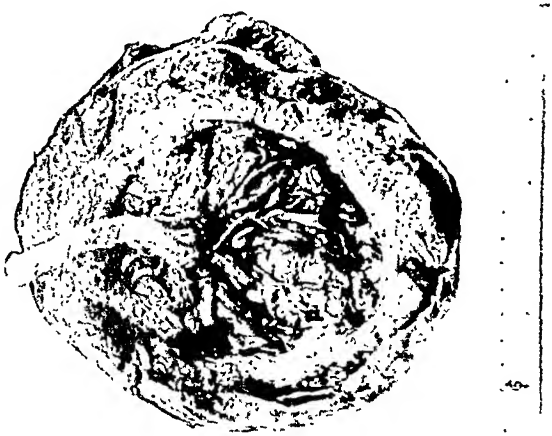

Fig. 243.—Placenta circumvallata. (Author's case, Kensington Hospital for Women, Philadelphia.)

turning directly downward into the substance of the organ before reaching the edge of the ring (Fig. 243).

The mode of origin of placenta circumvallata has given rise to a large literature, there being many theories regarding it. The whole matter has been very well reviewed by Williams,[23] who surveyed the literature and came to the conclusion that the essence of the abnormality lies in the restricted area of the chorionic plate, the folding of the membrane and the presence of a layer of decidua upon the extrachorionic portion of the fetal surface of the placenta. This striking anatomical anomaly has no clinical significance except in its occasional association with widespread placental infarction.

DISEASES OF THE UMBILICAL CORD

Variation in Length of the Cord.—The average length of the umbilical cord is given by Naegele[40] as from 34 to 48 cm. while Lariot[41] gives from 50 to 60 cm. as the normal length. Von Winckel says that the cord is approximately as long as the fetus or about 50 cm. in a mature child.

Very marked variations in length may occur, a cord of 198 cm. having

cord insertion, finding 73 per cent eccentric, 18 per cent central and 7 per cent marginal, and adds that these variations possess no clinical significance.

Velamentous Insertion.—Occasionally the vessels of the umbilical cord separate at varying distances from the placenta and reach their placental termini by taking their course between the amnion and chorion, or are enveloped in a fold of the former tissue. This condition, termed *insertio velamentosa,* has been estimated by various observers as occurring in from 0.4 to 0.9 per cent of all cases. Williams found it in 1.25 per cent of the series described above. The condition is much more frequently observed in multiple than in single cases, Miranoff[46] giving the occurrence as 5 per cent in twins.

The genesis of this anomaly has given rise to much speculation. The theory of Franque[45] is now generally accepted, that is, that the abdominal pedicle ordinarily extends to the fetus from the most vascular portion of the chorion, usually that in contact with the decidua basalis, and hence the cord becomes inserted into the placenta. Sometimes, however, in early pregnancy the most vascular portion of the ovum may be in the decidua capsularis, in which case the abdominal pedicle takes its origin from this tissue. As pregnancy advances, however, the decidua basalis eventually becomes the most vascular area and while the abdominal pedicle retains its original position, the vessels extend from its maternal end to the placental margin.

Velamentous insertion of the cord is of some clinical importance, several cases of fetal death from rupture of such cords being recorded. Kosmak[47] reports a typical case in which free vagina bleeding occurred at term, with loss of fetal movements and heart tones. On cesarean section (performed in the belief that abruptio placentae was present), there was found a velamentous insertion of the cord with rupture of its vessels and consequent fetal death. The diagnosis of this condition is naturally very difficult but its presence may be suspected when moderate bleeding occurs during the first stage of labor, with no evidence of placenta praevia or abruptio placentae. Absolute diagnosis is possible only when the pulsating cord vessels (vasa praevia) are palpable within the cervix, over the bulging membranes. Should the anomaly be suspected, prompt delivery by the most available method is the only treatment.

Torsion of the Cord.—The cord may become more or less twisted as a result of fetal movements. The condition is found frequently in aborted fetuses but is uncommon in the mature infant.

The twisting is sometimes marked, 380 turns being noted in a case of Schauta's, such extreme torsion being obviously incompatible with fetal life. When a twisted cord is found in the presence of a dead fetus, it is generally impossible to determine whether the torsion caused fetal death or whether the twisting occurred during the active movements of the fetal death agony, or, indeed, whether the twisting occurred after the death of the child. This subject has been carefully studied by Browne[48] who quotes Dohrn as having collected 85 cases of fetal death from this cause.

A certain degree of torsion is physiologic, the vein being twisted about the deeper lying arteries, usually from right to left; and in thin cords, with little of Wharton's jelly present, this torsion may readily become so marked as to interfere with the fetal blood supply and, indeed, to cause death from as-

Solid Tumors of the Cord.—This excessively rare condition has only been reported eight times in the literature and according to Browne[43] no case has been published since 1891.

Of these eight tumors three proved to be telangiectatic myxosarcoma, two were teratomatous in origin, one a myxangioma, and in two histologic investigations were not carried out.

Varices of the Cord.—This rare tumor of the cord has been described five times in the literature, according to the exhaustive article of Adair.[49] These vascular tumors, though rare, are of clinical importance because of the grave danger to the fetus, whose life is dependent upon the integrity of the tumor wall, which may or may not rupture as pregnancy proceeds.

The varices differ in size, the smallest one reported being the size of a hazelnut while the largest was some 12 cm. in diameter, and among the five

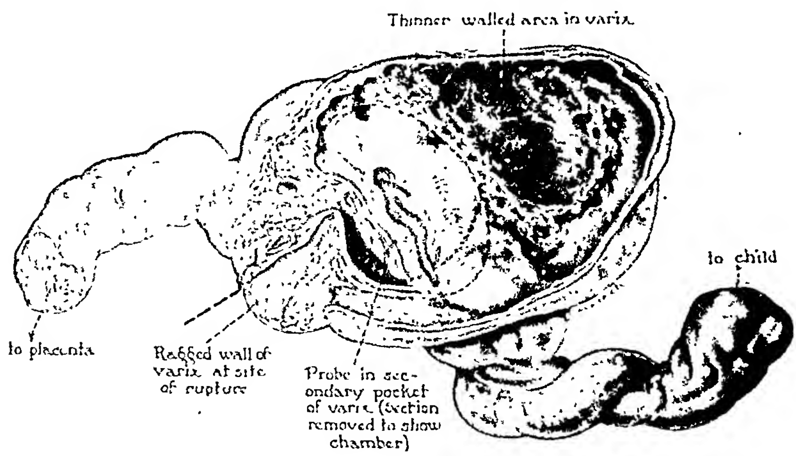

Fig. 245.—Shows primary pocket of varix lined with deposits of fibrin. This also shows the venous openings into the varix cavity. (Adair and McDonald in Amer. Jour. of Obst. and Gyn., June, 1929, published by C. V. Mosby Co.)

reported cases three types of varix may be differentiated, three being of the thin-walled type with a relatively large cavity, one a small tumor with thickened walls and one a simple dilatation of the umbilical vein as it entered the umbilicus. Four of the five infants were stillborn (Figs. 244, 245).

Edema of the Cord.—Edema is rarely present with a living infant in good condition, but is common in certain fetal diseases, notably general edema, as reported by the writer, and it is also often found with dead and macerated fetuses. Sometimes an undue increase in the amount of the jelly of Wharton present in the cord produces an erroneous impression of edema. The condition seems to be of no clinical significance, except as a part of a general fetal dropsy.

Inflammation of the Cord.—Inflammatory lesions of the cord, exclusive of those of syphilitic origin, are rarely met with as long as the child is alive but are reasonably common after its birth. In most instances, the cord be-

being marked by the dimples over the posterior superior spines of the ilia. The lower angle is indicated by the groove at the base of the spine. The posterior limb of the calipers should be placed near the apex of the rhomboid. It is wise to take this measurement twice in order to avoid any possible error. This diameter may be measured with the woman standing erect, or while she lies upon her side.

Baudelocque believed that by deducting 8 to 8.5 cm. from this diameter the length of the true conjugate could be obtained. Observations by many workers have since shown that this is untrue and that the relationship between these two diameters is not sufficiently constant to enable one to rely upon it for an accurate estimate of the real length of the true conjugate.

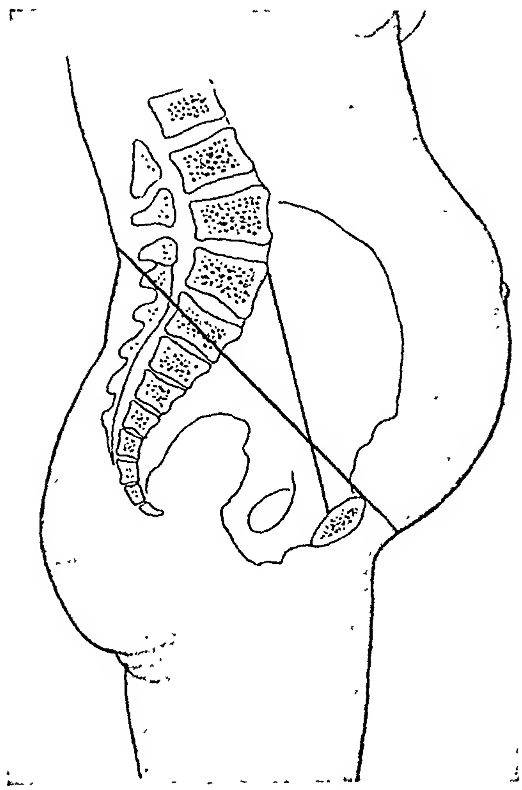

Fig. 349.—Relationship of the external conjugate or Baudelocque's diameter to the true conjugate. (Stoeckel.)

As a rule, however, when the external conjugate is normal in length, 20 to 21 cm., the true conjugate will also be found of normal length. Williams remarks that when the external conjugate measures between 18 and 19 cm. about one half of the cases will be found to have an internal conjugate of less than normal length, and that when the external conjugate is less than 17 cm. contraction is almost always present.

It is well to remember that normally the interspinous diameter is 2.5 to 3 cm. less than the intercristous diameter. When all external measurements are less than normal, but this relationship is preserved, the pelvis is probably a generally contracted one. When this difference between the two is altered, and the two diameters tend to become of equal length, one may be reasonably

14. Ballantyne, J. W.: Antenatal Pathology and Hygiene, Edinburg, 1904, vol. i, 167.
15. Siddall: Amer. Jour. Obst. and Gyn., 1928, xv, 828.

PLACENTA

16. Siddall and Hartman: Amer. Jour. Obst. and Gyn., 1926, xii, 683.
17. Young: Jour. Obst. and Gyn., Brit. Emp., 1914, 2611 (quoted by Thoms).
18. Clementz: Zeitsch. f. Geburts. u. Gynak., 1922, 84, 759 (quoted by Thoms).
19. Paddock and Greer: Amer. Jour. Obst. and Gyn., 1927, xiii, 164 (literature).
20. Thoms: Amer. Jour. Obst. and Gyn., 1929, xvii, 176.
21. DeLee: Principles and Practice of Obstetrics, Saunders, 1929, 600.
22. Clarke, John: Philosophical Transactions, London, 1798.
23. Siddall, R. S.: Amer. Jour. Obst. and Gyn., 1924, viii, 430.
24. Emge: Amer. Jour. Obst. and Gyn., 1927, xiv, 35.
25. Margeson: Boston Med. and Surg. Jour., 1920, clxxii, 220.
26. Senge: Beitr. z. Path. Anat. u. z. Ang. Path., Jena, 1912, Bd. 53, Ht. 3.
27. Walz: Verhandl. d. Deutsch. Path. Gesellsch., 1907, 10, 279.
28. Williams: Obstetrics, New York, 1930, 737, and Amer. Jour. Obst. and Gyn., 1927, xiii, 1.
29. Norris: Gyn. and Obst. Tuberculosis, D. Appleton & Co., New York, 1921, 31.
30. Warthin: Jour. Infec. Dis., 1907, 4, 347.
31. Leff: Amer. Jour. Obst. and Gyn., 1931, xxii, 117.
32. Schumann: Amer. Jour. Obst., 1915, lxxii.
33. Opitz: Zeitsch. f. Geburts. u. Gynak., 1902, 112.
34. Polak and Phelan: Surg., Gyn., and Obst., 1924, xxxviii, 181.
35. Feiner: Amer. Jour. Obst. and Gyn., 1931, xxii, 312.
36. Kraul: Zeitsch. f. Gynak., 52, 1928, 828.
37. Nathanson: Amer. Jour. Obst. and Gyn., 1928, xvi, 44.
38. Tennant, Wilson, and Craig-Sullivan: Colo. Med., 1925, 22, 145.
39. Nyulasy: Jour. Obst. and Gyn., Brit. Emp., 1909, 16, 9–15.

UMBILICAL CORD

40. Naegele: Quoted by Lariot.
41. Lariot: Bull. Soc. d'Obst. et de Gyn., de Paris, 1924, xiii, 256.
42. Gardiner: Surg., Gyn., and Obst., 1922, xxxiv, 252.
43. Gardiner: Jour. Amer. Med. Assoc., 1932, 98, 598.
44. Adams: Amer. Jour. Obst. and Gyn., 1925, ix, 690.
45. Franque: Zeitsch. f. Geburts. u. Gynak., 1900, 43, 463.
46. Miranoff: Quoted by Kosmak.
47. Kosmak: Amer. Jour. Obst. and Gyn., 1922, iv, 619.
48. Browne: Jour. Obst. and Gyn., Brit. Emp., 1925, xxxii, 17.
49. Adair: Amer. Jour. Obst. and Gyn., 1929, xvii, 836.
50. Siddall: Amer. Jour. Obst. and Gyn., 1927, xiv, 192.

to measure the anterior and posterior sagittal diameters of the outlet. DeLee's outlet pelvimeter, a modification of that of Ayres, is also useful. The bi-

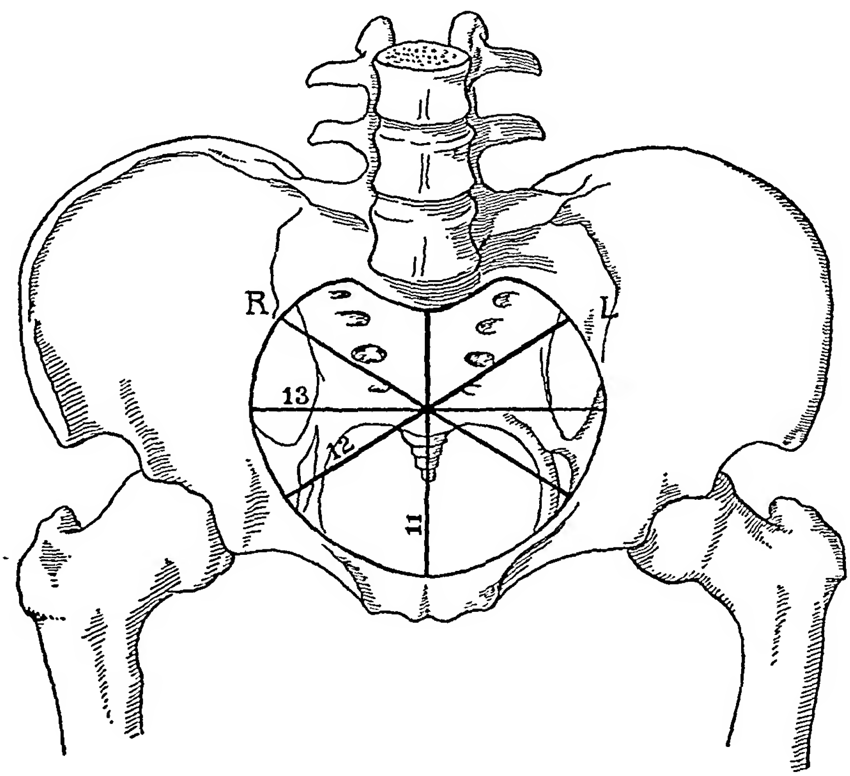

Fig. 353.—Pelvis seen from above, showing diameters of inlet. (Redrawn from Bumm.)

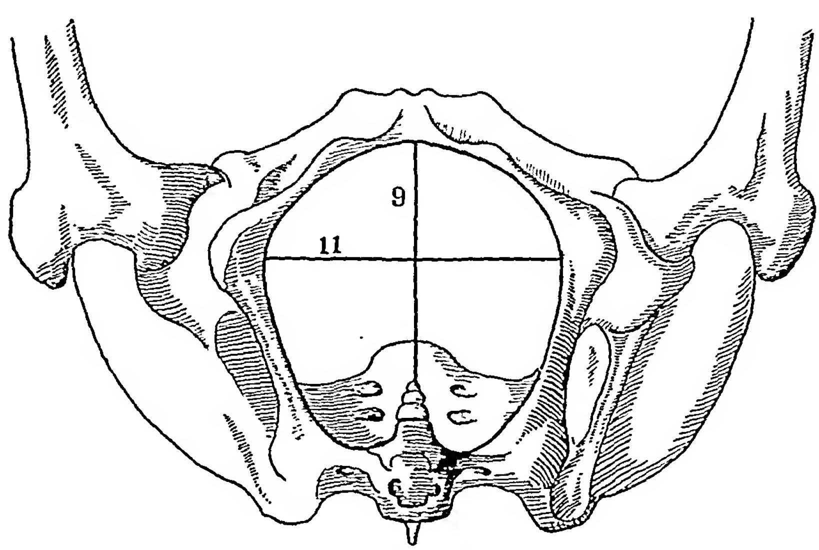

Fig. 354.—Pelvis seen from below, showing diameters of outlet. (Redrawn from Bumm.)

ischial diameter in a normal pelvis is 11 cm. This diameter normally is 9.5 cm. on the scale of the instrument. To this should usually be added 1 to 1.5 cm. to allow for the soft tissues under the instrument. As Neu re-

The portion of the osseous system, aside from the pelvis, which is of greatest importance to the obstetrician is the skull, and this will be considered in some detail. The bones of the cranial vault mostly develop from the connective tissue capsule which covers the brain superiorly, laterally, anteriorly, and posteriorly. The bones at the base of the skull develop mainly from cartilage.

The fetal skull consists of bones and their component parts which gradually become fused before and after birth.

The os occipitale is made up of five parts, each with distinct centers. They are the pars basilaris, the two partes laterales and an upper and lower segment of the squama occipitalis. The ossification centers appear here about the tenth, eighth, and ninth weeks, respectively.

The os parietale of either side is membranous in origin and an upper and a lower center appears in each about the end of the second month. Each os temporale develops from three bones which are persistent at birth, the squama temporalis, the pars tympanici and the pars petrosa, the latter alone being of cartilaginous origin. Ossification centers appear in these different portions during the second, third, and fifth months respectively. The os frontale of either side is of membranous origin. Ossification takes place from a primary center which first appears toward the end of the second month. There are additional accessory centers which unite with the main centers. The two frontal bones are united at birth.

The details of the ossification of the os sphenoidale, os ethmoidale, os lacrimale, and the others making up the cranium and face are not of especial obstetrical interest.

The sutures and fontanels are of great importance not only because they increase elasticity of the head and permit easier molding but because they are valuable in the diagnosis of the position of the fetal head in the birth canal. At birth they persist as unossified portions of the membranous skull capsule. The fonticuli are six in number, two are single and two are paired. The unpaired ones are fonticulus frontalis (major) and the fonticulus occipitalis (minor); the paired ones are the fonticulus sphenoidalis and the fonticulus mastoideus.

There are many more sutures than fontanels, some of which are of little obstetrical importance. Most, but not all of them, communicate with some one of the fonticuli. Their names follow and if the nomenclature is not descriptive, a brief statement is given as to their location: (1) The sutura parietomastoidea; (2) sutura occipitomastoidea; (3) sutura lambdoidea, between the squama occipitalis and the two parietal bones; (4) sutura mendosa, an indenture between the portions of the squama occipitalis; (5) sutura sagittalis, which lies between the two parietal bones; (6) sútura parietalis, which is found in 4 or more per cent of fetal skulls in about the midportion of one or both parietal bones communicating with the sagittal suture; (7) sutura squamosa, which lies around the squamous portion of the temporal bone; (8) sutura coronalis, lying between the frontal and parietal bones; (9) sutura frontalis, occupying the space between the two frontal bones. The names of the following are practically descriptive of their location: The (10) sutura sphenoparietalis; (11) sutura sphenosquamosa; (12) sutura sphenofrontalis; (13) sutura sphenozygomatica; (14) sutura nasofrontalis; (15) sutura frontomaxillaris; (16) sutura nasomaxillaris; (17) sutura zygo-

Diameters.	1 White.	1 Colored.	2	3	4	5
F. O.	11.71	11.26	12.2	12.0	12.0	11.0
M. O.	13.33	13.31	12.0	13.5	13.5	13.0
S. O. B.	9.70	9.29	10.6	9.5	9.5	9.5
B. P.	9.25	9.05	9.7	9.25	9.25	9.5
B. T.	8.00	7.81	....	8.0	8.0	8.0
F. O. C.	34.5	.....	35.2	34.0	34.0	34.0
S. O. B. C.	32.0	.....	33.0	32.0	32.0	31.0

1. Williams, J. W.
2. Scammon, R. E., and Calkins, L. A.
3. Sellheim, H.
4. Bumm, E.
5. DeLee, J. B.

According to Scammon and Calkins, the largest circumference is the mento-lambda which measures, on the average, 37.14.

The presence of certain ossification centers may assist in the diagnosis of maturity. No ossification centers are present in the carpus at the time of birth as a rule, though probably a center may be found in the os magnum or the unciform in about 15 per cent of newborn infants. Ossification occurs somewhat earlier in the tarsus and one or more centers may be found in about 4 per cent during the ninth fetal month, in about 27 per cent during the tenth fetal month, and in nearly 61 per cent at birth. The centers at the knee joint give valuable information as to fetal age. The center for the inferior femoral epiphysis is not present before the eighth fetal month and appears in only about 5 per cent during this month; it is present during the ninth month in about 32 per cent, during the tenth fetal month in 84 per cent, and at birth and in the first postnatal week in 95 per cent. The superior tibial epiphyseal center is seen in only 6 per cent of fetuses during the ninth fetal month, in 41 per cent during the tenth fetal month, and occurs in 77 per cent of infants at term.

The placenta in reality consists of both maternal and fetal tissues; the former are derived from the endometrium which becomes modified to form the decidua in which the nutritive vascular channels of the mother lie. Columns and areas of decidua are spread over and through the placenta to interdigitate with the numerous villous processes which are derived from the embryonic trophoblastic cells and which are filled with fetal blood and tissue fluids. Not only must the fetus receive its nourishment through these cells but all the excretory products must be eliminated, except possibly a small amount of urine which may be excreted into the amniotic fluid and some products which may be stored up in the intestinal tract.

The passage of water through the placenta in either direction is closely associated with the maintenance of mineral balance between the fetal and maternal fluids. The maternal fluids containing nutritive materials in solution can pass freely through the placenta to the fetus and the fetal fluids laden with waste fetal products must pass with equal freedom in the opposite direction (Feldman).

The passage of carbohydrates through the placenta is important. The transmission of glucose has been studied considerably and the prevailing

frequently sees previable fetuses make movements of the respiratory muscles. It is not definitely known that respiratory movements occur in utero but it is commonly assumed that they do; just what sensory, chemical or other stimulus excites the respiratory center at birth is not known. We can demonstrate respiratory movements before the head is born in breech extractions and versions. Aspiration of fluid and meconium occurs before delivery, as is sometimes seen in stillborn infants. The respiratory response probably results from some alteration in circulation. We know that respiratory action can be stimulated by various mechanical, thermic, and other peripheral excitants.

We know very little about the workings of the central and peripheral nervous system or about the sympathetic nervous system, except that certain functions are performed prior to birth and that these processes are carried on after birth. The gastro-intestinal tract performs no functions except possibly those already indicated but the structures are ready to act in accordance with the demands of extra-uterine life, even before the fetus reaches maturity, although they perform rather imperfectly if the fetus is immature. The skin and its appendages act, and large amounts of sebaceous vernix are at times produced.

There are some muscular actions such as those of sucking, deglutition, contractions of the bladder, etc. We are very certain of the movements of the skeletal muscles, which take place from early pregnancy and continue with increasing vigor throughout gestation.

After the fetus has once attained its form in the third month of pregnancy the main change is one of growth. This is not proportional for all parts of the body but it is a continuous process throughout fetal life.

The fetus grows and develops regularly and its size and appearance are a fairly accurate gauge as to its probable age.

Lunar month.	Length.				Haase's rule.*	Weight.	
	C. R.		C. H.				
	1	2	2	3		1	3
First	0.04	0.0	.....	.....	1		
Second	0.23	.....	.....	3.0	4	1.1	
Third	6.1	5.17	7.08	9.8	9	14.2	24.0
Fourth	11.6	10.76	15.54	18.0	16	108.0	70.0
Fifth	16.4	15.54	22.79	25.0	25	316.0	230.0
Sixth	20.8	19.77	29.20	31.5	30	630.0	620.0
Seventh	24.7	23.63	35.05	37.1	35	1045.0	1250.0
Eighth	28.3	27.18	40.43	42.5	40	1680.0	1600.0
Ninth	32.1	30.51	45.47	47.0	45	2478.0	2200.0
Tenth	36.2	33.63	50.20	50.0	50	3405.0	2950.0

1. Williams, J. W.
2. Scammon, R. E., and Calkins, L. A.
3. Dietrich, H. A.

* Haase's rule is to square the serial number of the month up to and including the fifth and multiply this number by five through the tenth month. Scammon and Calkins give the following formula for determining C. H. length

$$L = 28\sqrt{T - 0.74} - 35$$

in which L = the C. H. length and T = lunar month.

falsehood. Even now the great subject of antenatal pathology is assumed by many medical men to be limited to teratology—a grievous error. It must be remembered that the child is by no means a little man, that physiologic processes, both normal and pathologic, differ greatly in the infant and the adult and that the manifestations of disease vary within wide limits in the developmental and mature epochs of life. The entire period of intra-uterine life, forty weeks, represents a trifle more than 1 per cent of man's terrestrial career, if the classic expectation of life, three score and ten years, be taken as a basis; but if the relation between prenatal and postnatal life be measured by events rather than by time alone, the prenatal period is seen to be crowded with morphological changes and developments, compared to which all the physical phenomena which may occur during the entire passage of extra-uterine life are but trifles.

If we consider that within the short space of forty weeks the microscopical ovum united to the equally microscopical spermatozoon, grows into an organism 7 or more pounds in weight, with all of its many viscera and systems of viscera completely organized to maintain life, and, further, that in this period are laid down the potentialities for the indefinite continuation of the species, the relative importance of antenatal life will readily be understood.

Between the intra-uterine existence of the fetus and postnatal life there lies the mechanism of parturition, and the twelve hours more or less which the fetus spends in traversing the birth canal has been well said to be the most momentous epoch in the life of the individual and the one most fraught with dangers and accidents, any one of which may entirely change the subsequent course of his life.

It is the grouped study of these phenomena and occurrences of prenatal and intranatal life, their effect upon the individual, their relation to other departments of biology, medicine and sociology, that truly constitutes antenatal pathology.

The relationship of the subject to pediatrics is obvious, but the relationship between it and certain other branches of medicine is more remote though equally definite. For example, a mother suffering from the toxemia of late pregnancy gives birth to an infant which, although affected by the toxin, eventually recovers and grows to maturity. The fetus may be, and doubtlessly is, affected to varying extents by this toxin, which may be protein in its origin.

We are coming to realize more and more that the cardiovascular system, the kidneys and the liver of the toxemic mother, despite their enormous reserve and recuperative powers, suffer permanent damage to a greater or lesser degree. This may manifest itself in subsequent pregnancies, or in later life. We do not know what effect these toxins produce on the fetus, but it is only fair to assume that, inasmuch as we believe that the fetus dies in utero from the effect of these toxins, it may suffer lesser damage to its tissues and organs. Such impaired and destroyed cells may lessen the reserve powers of various organs and increase the susceptibility to various disease processes with resultant disability and even death, which would not have occurred at that time had not the individual been damaged during intra-uterine life.

In the field of obstetrics and gynecology such examples of obscure rela-

During the embryonic period we have, then, two great factors which may produce abnormal development, hereditary influence or disturbance in the germ plasm, and traumatisms or intoxication of the embryo from external causes (Huber).

Immediately following the embryonal period there is recognized a vague neofetal period of about two weeks' duration, during which the placenta is completed and its circulation developed and adapted to the needs of the fetus. During this time the pathologic changes which usually occur are circulatory in their nature, due to some error of adaptation of the fetal and maternal structures to the newly formed placental circulation. Then follows the great fetal period, or the time of enormously rapid growth and hyperplasia. From the eighth to the fortieth week of pregnancy, growth is the keynote of fetal development. The plan of the body has been laid down, the essential cells are in place, and there remain but their multiplication and increase along the lines arranged during embryonal life to complete the mature fetus.

It must be remembered, however, that growth and organogenesis do not move along in parallel courses, all organs and systems of organs developing at a uniform rate and reaching maturity at the same time. On the contrary, the growth and development are markedly irregular. The reproductive tract, for instance, does not reach maturity at all during intra-uterine life, but its organs remain undeveloped for more than a decade of postnatal existence, when, with puberty, their full growth is reached. So, also, with the epiphyses of bones, the teeth, the hair, the mammary glands, and other tissues.

On the other hand, certain organs reach maturity early in intra-uterine life and are already in retrogression at birth. The thymus is an example.

Should arrest of development occur during this period of growth, one organ or system of organs is more likely to be affected than the entire fetus, since, as has been pointed out by the writer in a previous article, all organs or systems of organs attain their growth, not synchronously and regularly, but irregularly, each group having a period of maximum rapidity of development and cell reduplication and the neighboring tissues remaining fairly quiescent during this period. It is this event in the developmental cycle of the organs, or system, which has been termed the "critical period." Furthermore, there is a mutual inhibitory mechanism acting between neighboring organs or tissues, by which the size and extent of growth of each part is regulated. Should the inhibitory mechanism be disturbed by error in development of one organ or tissue, the effect would naturally be to increase the growth of the related tissues, either along the normal line, or, by reason of the control being lost, to force development into abnormal directions. This will explain the occurrence of many of the minor forms of abnormal tissue formation which take place during the fetal period and which are caused by some disturbance of the maternal growth control, the disturbance being brought about by nutritional insufficiency or other similar influence. The fetal period is ended by the phenomenon of birth, by which process the fetus changes from a parasite, existing solely by its maternal blood supply, into an independent creature, supplying oxygen for its own needs by means of its own self-contained mechanism. The two weeks after birth have been termed the neonatal period, and during this time the newborn infant is adjusting itself to its independent existence. The heart is being regulated, its valves becoming competent; the heat centers are adjusted to maintain constant body temperature, regardless

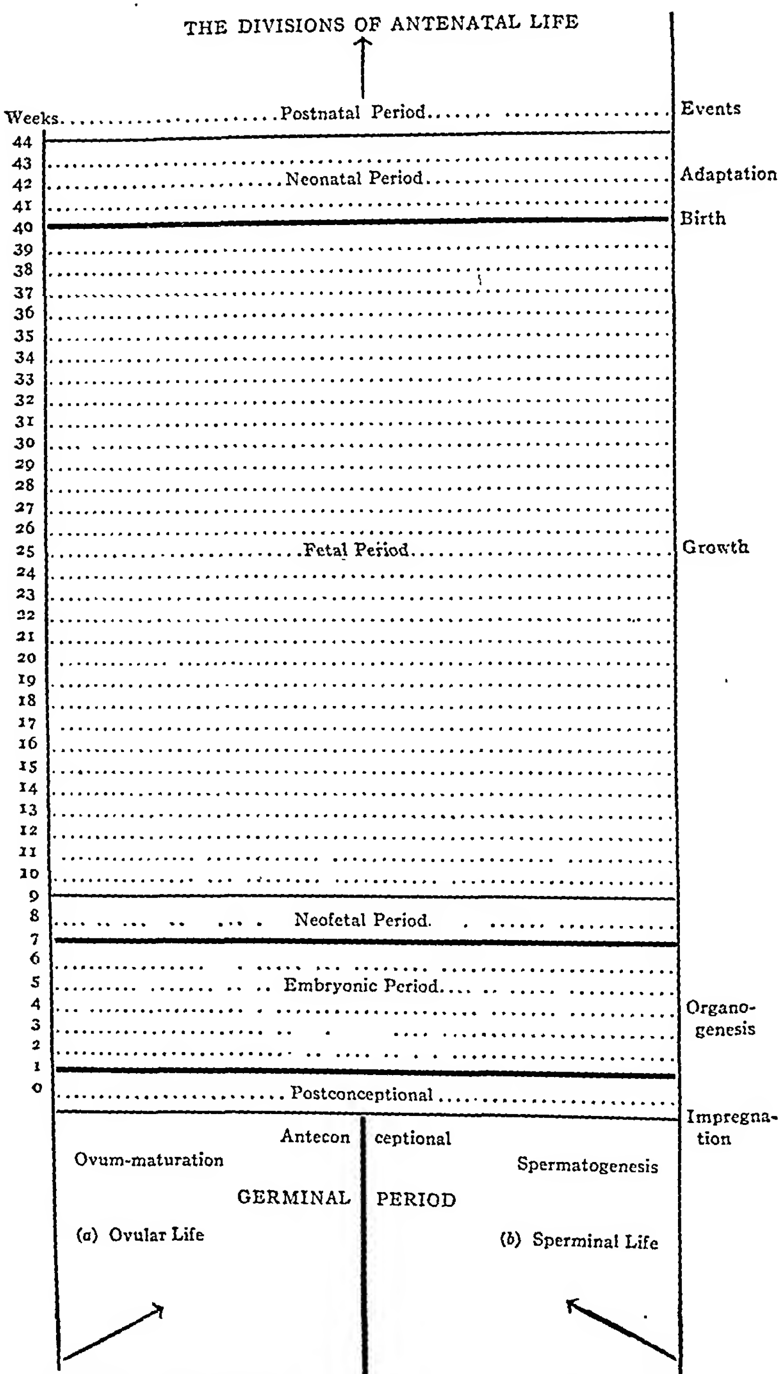

Fig. 251.—Chart showing the divisions of antenatal life. (Ballantyne.)

After these two weeks of neonatal adjustment, postnatal life begins, and the events of life follow their appointed steps until death and decay terminate the cycle.

ology, debased superstition and fantastic speculation there have emerged certain workable hypotheses, portions of which have been substantiated by experimental evidence.

First, the theory that terata may be caused by faulty implantation of the ovum, with resulting impairment of nutrition and interference with normal physiologic processes. The work of Dareste, Mall, Hertwig, and many others has emphasized the importance of this view, and experimental proof of the truth of the theory is not wanting. In general, the plan adopted by experimenters has been to subject the impregnated ova of certain easily studied animal forms to mechanical or chemical insult, in order to impair nutrition and provide an unfavorable environment. If such conditions are reproduced within the human uterus, the theory is strengthened. The work of Mall speaks strongly for the theory of faulty implantation. Mall found that not over 7 per cent of uterine pregnancies contain pathologic embryos, and, were the primary cause which produces them located in the germ, he would not expect a higher percentage in the ova from tubal pregnancies. Instead, it is found that 96 per cent of the embryos in tubal pregnancies are pathologic and but 4 per cent normal, and a study of these ova shows conclusively that the pathological character of the embryo is secondary to primary change in the chorion, caused by a faulty implantation, which, in turn, is usually due to some form of endometritis.

The theory of the importance of the amnion to the orderly development of the embryo has also received much attention. Generally speaking, this would seem to be included in the first mentioned theory of nutritional errors due to faulty implantation, but there may be morbid processes in the amniotic sac without any fault in the implantation of the ovum whatever.

The intimate relationship between the amnion and the embryo, and the close infolding of the forming tissues by this membrane, lead to the inevitable conclusion that imperfect separation of the amnion from the body of the embryo must lead to deformities, and as a result of the unequal pressure, exerted on the developing tissues. In addition, there is the evidence adduced from the study of monsters showing the close adhesion of undeveloped or maldeveloped members to bands of amnion.

The pressure of amniotic bands is not a necessary corollary, however, since it is perfectly reasonable to suppose that areas of marked pressure may exist inside the sac, without any direct adhesion whatever between embryo and enveloping membrane.

With this brief outline of the causative factors, we leave the pathology of the embryo. Contemplation of its intricacies leads the student into turbid and cloudy waters, which are, however, gradually being clarified as experimental evidence and hypothesis draw more closely together.

A study of the pathology of the fetal period, extending from the seventh to the fortieth week of intra-uterine life, offers a most fruitful field for scientific investigation, and a distinct hope for the betterment of the newborn child by a practical application of the principles which underlie it. Fetal pathology, paralleling fetal physiology, is that of growth. During this time organs have attained their function in a greater or less degree, and morbid agents produce reactions which are of the nature of disease rather than morphological anomalies, as in the preceding period. Fetal disease is directly comparable with postnatal morbid procedures, with certain essen-

CLASSIFICATION OF FETAL MORBID STATES

I. Transmitted diseases.
   1. The exanthemata, malaria, etc.
   2. Tuberculosis, sepsis, elephantiasis, etc.
   3. Syphilis.

II. Transmitted toxicological states.
   1. Lead poisoning, etc.
   2. Poisoning by morphine, mercury, strychnine, etc.
   3. Alcoholism.

III. Idiopathic diseases.
   1. Subcutaneous tissue and skin (general dropsy, ichthyosis, etc.).
   2. Osseous system (fetal rickets, achondroplasia, etc.).
   3. Alimentary system (fetal ascites, peritonitis, etc.).
   4. Respiratory system (pneumonia, hydrothorax, etc.).
   5. Circulatory system (endocarditis, hydropericardium, etc.).
   6. Hemopoietic system (thyroiditis, thymitis, hepatitis, etc.).
   7. Genito-urinary system (nephritis, distended bladder, etc.).
   8. Nervous system (paralysis, contractures, etc.).

IV. Neoplasms.
   1. Of the head and face (preauricular appendages, cysts, etc.).
   2. Of the neck (cervical cysts, chondromata, etc.).
   3. Of the trunk (sacral and coccygeal cysts, fibromata, etc.).
   4. Of the extremities (exostoses, lymphangiomata, etc.).
   5. Of the internal organs (sarcomata, rhabdomyomata, etc.).

V. Traumatic morbid states.
   1. Fractures.
   2. Dislocation.
   3. Wounds.
   4. Congenital "amputations."

VI. Diseases and morbid conditions of the fetal adnexa.
   1. Placenta (tubercle, edema, etc.).
   2. Umbilical cord (knots, rupture, etc.).
   3. Chorion (abnormal vascularity, etc.).
   4. Amnion and liquor amnii (adhesions, hydramnios, etc.).
   5. Decidual membranes (inflammation, etc.).

VII. Pathology of fetal death.
   1. Maceration, mummification, etc.
   2. Rigor mortis.
   3. Putrefaction.

It is merely possible to glance at some of the most important and common types of fetal disease within the limits of this article.

TRANSMITTED DISEASES

The Exanthemata, Malaria, Etc.—The exanthemata may, under certain unknown conditions, be transmitted from the mother to the fetus in utero.

Fetal variola has often been observed, the most famous case, probably, being that of the French obstetrician, Mauriceau, who was born with well-marked pustules, his mother having been exposed to the disease a few weeks before his birth. When a pregnant woman is attacked by smallpox it does not necessarily follow that the infant will be born showing the eruption on its skin. It may be born alive and be afterward immune from the infection, there may be evidence of pustule formation on mucous surfaces, or there may be placental infection with fetal death. Ballantyne thinks that

evidence that such invasion may not have followed an attack of amniotitis (*q. v.*).

Syphilis.—Much has been written concerning transmission of syphilis by the father, but it is generally conceded that maternal transmission is, by far, more common. Some believe that, while paternal transmission is unusual, it is possible. The mechanism of such paternal transmission is not at all clear.

The effect of syphilis upon reproduction is not fully known and the reader who is interested in having more complete knowledge can refer to Chapter LVI, on Syphilis in Women. The effect of the syphilitic virus upon the male and female germ cells is not known. Syphilis has frequently been referred to as a hereditary disease, but, strictly speaking, it is a congenital infection which may be transmitted from one generation to another.

It has been thought that fetal malformations result from old infections or are parasyphilitic manifestations; but one of the authors has been unable to demonstrate that monsters and malformations occur with any greater frequency among syphilitics than in nonsyphilitics. Postmortem examination of monsters and other malformed infants fails to reveal the existence of a syphilitic infection with any greater frequency than in those not so malformed.

Another common opinion is that syphilis is a frequent cause of abortion. Many early abortions are associated with malformed embryos, and syphilis does not appear to be a factor in the production of these anomalies. Results derived from analyses of a large series of pregnancies indicate that, statistically, early terminations of pregnancy are no more frequent in syphilitic than in nonsyphilitic women. In a study of a series of cases, one of us found the ratio of abortions to total pregnancies was about one to three in both syphilitic and nonsyphilitic women.

Browne, in his study of fetal syphilis, reached the same conclusion, and Buschke stated that syphilitic abortions were infrequent in the fifth month, increased in percentage rapidly during the sixth and seventh months to a maximum in the eighth lunar month which level was maintained during the succeeding month, to diminish in the tenth month to a small percentage born at term. It would seem, therefore, that premature termination of pregnancy during the last trimester of pregnancy, at which period occur probably two thirds of the terminations of pregnancy due to fetal syphilis, is much more characteristic of syphilis than the abortions occurring in the first two trimesters.

Among many factors which influence the effect of the syphilitic infection upon the fetus may be mentioned its virulence, its stage of activity, and the amount and duration of treatment. It is probable that the fetus may become infected with syphilis at different periods of pregnancy. The treponema may be carried into the maternal genitalia by the semen and thus gain access to the uterine mucosa, from which the fetus might be infected. There may be other and smaller forms of the treponema, which might be carried more directly to the embryo and fetus. The infecting organism may be carried through the maternal vascular system to the fetal vascular channels at nearly any period of pregnancy. It has been demonstrated in the decidua, the placenta, the umbilical cord, and the fetal tissues. The fetus may be infected during the process of birth, from active lesions of the genital passages.

The effect upon the fetus varies considerably. There may be early fetal

confidence. The mental make-up of the parent, weak or otherwise, may descend to the child, but inheritance is not influenced by passing activities. As a distinguished biologist put it "wooden heads are inherited but wooden legs are not."

The fear of "maternal impressions" is still met with. By this is meant physical or mental abnormalities of the child produced by mental shock or physical injury sustained by the mother. This belief that the unborn child may be so influenced has come down from the earliest days of written history and is said to prevail even among uncivilized races. Numerous references to it in nonmedical literature occur. Nearly all later teratological writers agree that no scientific evidence exists for such a belief.

When the pregnant woman expresses a fear that her child may be "marked" she may be told clearly and with entire confidence that no such occurrence is possible.

Briefly, the evidence against it may be summed up as follows:

1. No nervous communication between the mother and fetus has been demonstrated.

2. In many cases of physical abnormality of the fetus the abnormality must have been present before the event which is supposed to have caused it occurred.

3. Many women who deliver physically defective infants have had no disagreeable experience to which to charge the event. Conversely, many women have been known to pass through various harrowing experiences without any abnormality of the child resulting.

4. All of the physical abnormalities observed in human infants are seen in the young of lower animals. That these were caused by impressions produced upon the mind of the mother animal could scarcely be insisted upon.

Determination of Date of Labor.—The usual rule, suggested by Naegele, is to count nine months ahead from the first day of the last menstruation and add seven days, or, as is easier, to count back three months and add seven days. In about 60 per cent of cases this will be correct within eight days in either direction. When only one coitus has occurred one may count two hundred seventy-three days from this date, which is usually correct within seven days.

It must be recognized that pregnancy varies in length and no method can be wholly accurate. Further, in most cases neither the date of ovulation nor the date of the fruitful coitus can be known. It seems probable that in most women ovulation occurs about ten to fourteen days after the end of menstruation but one cannot be certain that this is so in every case. While the average length of gestation is two hundred eighty days Williams has noted that in many young women who miss the first period after marriage, a normally developed child is born two hundred eighty days from the beginning of the last menstrual period. This would indicate that pregnancy does not always last ten lunar months. The estimation of the date of delivery from a single coitus is open to inaccuracy for the following reasons:

1. The exact date of ovulation is not known.

2. It is not known how long the spermatazoon may be in the reproductive tract before fertilization of the ovum takes place.

3. The length of pregnancy itself is known to vary.

The estimation of the date of delivery from the date upon which fetal

Idiopathic Diseases

The idiopathic diseases of the fetus may be defined as all those definitive lesions whose cause is not known. The term "idiopathic" is at best a poor one and is used in the classification merely to indicate conditions of unknown origin.

General Edema of the Fetus.—This has been well defined by Ballantyne as "a morbid condition of the fetus characterized by general anasarca, by the presence of fluid effusions in the peritoneal, pleural and pericardial sacs and usually by edema of the placenta," and it results in the death of the fetus or infant before delivery or very soon after birth. Many factors have been regarded as causative in this condition but very little is definitely known about it. In general, it may be stated that the causes fall into two great

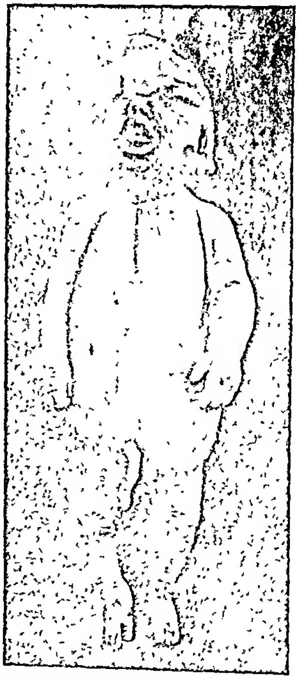

Fig. 252.—Fetal ascites and anasarca. Anterior aspect. (Specimen from the collection of the Göttingen Women's Clinic.)

Fig. 253.—Fetal ascites and anasarca. Lateral view showing the site of perforation. (Specimen from the collection of the Göttingen Women's Clinic.)

groups. The first, mechanical causes, including such fetal diseases as blood dyscrasias and so on, may be dismissed with the comment that such morphological conditions may or may not cause a general edema, according to whether or not they conform with normal circulation.

The second group, however, those due to toxemia, offers opportunity for speculation. It is probably that the development of this variety, comprising much more than half the cases, may reasonably be considered as due to the orderly sequence of a chain of factors, each one of which may be adduced by a careful study of the case histories, from the mechanism of the production of edema in general and from a study of the facts concerned in placentation.

ately after birth. Nothing is known as to the origin of the condition, the most striking pathologic picture being the enormous thickening of the epidermic layer. The parents in reported cases have been uniformly free from skin disease. Syphilis is not an etiologic factor. Milder forms of this disease may occur, a thin, continuous layer of a collodion-like substance covering the body, this material desquamating in small flakes shortly after birth (Fig. 254).

Congenital myxedema is very rare. In this disease, the skin and subcutaneous tissues have a swollen, edematous character, due to a defect in the thyroid gland. Whether the condition is due to the presence of mucin or only an infiltration is not certain.

Fetal Bone Disease.—The pathologic conditions which affect the skeleton of the fetus may depend upon hereditary influences, chemical or nutritional disturbances, hormonal activity and mechanical factors from contained structures or external causes. The skeleton as a whole may be involved or only individual parts may be affected, associated with the formation of minor and major malformations. In addition one has to consider the skeletal alterations associated with the formation of double monsters which make such serious obstetrical complications. One can divide these skeletal changes into three main groups:

1. General disturbance of bone development and growth.
2. Local defects and anomalies of development.
3. Defects associated with major malformations, monsters, and fused multiple pregnancies.

No elaborate consideration of these conditions could be given in a short chapter but the obstetrician must be more or less familiar with some of the varied skeletal changes which occur in the fetus.

Fetal achondroplasia is occasionally seen and while this disease is not likely to cause dystocia, it is incumbent upon the practitioner to recognize it. It has been known as chondrogenesis imperfecta, chondrodystrophia fetalis, osteochondrodystrophia fetalis, fetal rickets, and dwarfism. In this disease the characteristic deformity is that of marked shortening of the extremities. Epiphyseal growth is disturbed but periosteal bone formation continues. The membranous bones do not seem to be involved, which accounts for the peculiar shape of the bradycephalic head in these dwarfs (Fig. 255). The etiology is unknown but it is not unlikely that there is some hereditary factor or some growth hormonal disturbance. The roentgenogram is characteristic with a peculiar appearance and shortening of the long bones. The pelvis has a character which is somewhat peculiar to this disease.

The existence of *fetal rachitis* is still open to question though the name has been applied to achondroplastic disease. *Fetal osteopsathyrosis* or *osteogenesis imperfecta*, also termed fetal rickets and osteomalacia congenita, is an antenatal condition, which is analogous to diseases occurring in infants and adults and characterized by marked fragility of the bones. The etiology is not known but there is doubtless some disturbance of calcium metabolism. The skeletal structures seem to have their normal proportions but an apparent shortening of the extremities occurs due to multiple fractures of the long bones, the *x*-ray appearance of which is characteristic. Most of the subjects of this condition are either stillborn or succumb in the neonatal period.

Tumors of Fetal Bones.—*Multiple cartilaginous exostoses* occur and are the result of disturbed endochondral growth. Small cartilaginous tumor

of thyroid gland or its derivatives should give obstetricians a means of prophylaxis. This type of dwarf shows a general lack of development and the skeletal changes resemble those of the true dwarf.

The rachitic and achondroplastic dwarfs do not come under consideration here; the former is an acquired condition and the latter has already been mentioned. There are various classifications of dwarfs and usually the condition is not recognized at birth, although the congenital types are dependent upon either hereditary or congenital factors. True *dwarfism* is rare and it is characterized chiefly by a proportional impairment of general growth. There is a persistence of the epiphyseal cartilages. The pelvis is of the childhood type. Ossification eventually occurs but is somewhat delayed. The true or hypoplastic dwarf is a miniature adult with a persistence of the childhood type of development.

In contradistinction to dwarfism, one can mention *gigantism*. Guggisberg in Halban and Seitz recognizes two main varieties which are not generally accepted:

I. *Abnormal Height.*—(*a*) Physiologic type which is familial and hereditary. There is proportionate growth and that of the skeleton is also excessive but it ceases at maturity. (*b*) Pathologic tallness.

II. *Gigantism.*—(*a*) Essential gigantism or *macrosomia essentialis*. This is true gigantism in that these individuals are proportionate and conform to the normal type in respects other than their size. (*b*) The pathologic macrosomia which is associated with some disease or abnormality. The obstetrician has particular interest in fetal gigantism, as an oversized fetus may cause one of the most serious types of dystocia. Fetal gigantism may be said to exist when the fetus weighs 5000 Gm. or more. Keibel and Mall may be quoted as stating that bony overgrowth may be due to (1) excessive activity of membranous and subperiosteal ossification, (2) prolonged activity of growing epiphyseal cartilages and delayed union of epiphysis with the cartilage while endochondral ossification continues beyond the usual time.

Teratomata

Congenital malformations or monsters are not examples of fetal disease, in the strict sense, since these aberrations in morphology are of germinal origin and should therefore be considered among the defects of the germ plasm in the earliest days of embryonal development. Hence, only a few general facts will be here stated.

A teratoma or monster, according to the excellent definition of Schwalbe, is an alteration occurring during embryonal development, *e. g.*, a congenital alteration of one or more organs or systems of organs or of the whole body, which does not come within the range of variation of the species.

These structural anomalies may be divided into two great groups, those which are hereditary and germinal and cannot be reproduced, and those which are not hereditary, but are due to some mechanical injury or disease. Many merosomatous terata (anatomical anomalies and variation of extremities) and possibly some cases of arrested development, as harelip, are germinal and cannot be reproduced.

For the classification and grouping of monsters, the authors have employed Birnbaum's modification of Ballantyne's arrangement.

(*a*) Single monsters.

trance of the needle into the amniotic cavity being recognized by the appearance of amniotic fluid through the needle. The opaque fluid is then introduced slowly, a little amniotic fluid being allowed to escape, and about a half hour is allowed to elapse in order that the opaque fluid may thoroughly diffuse in the amniotic fluid. The woman is asked to move about in order to favor this. These authors believe that clear shadows of the fetus are obtained due to a better contrast between it and the fluid in which it lies. They had no untoward results in their series of cases. Until more experience is available the method had best be restricted to experts in the field of radiology.

Final Examination.—At the beginning of the ninth month an examination should be made. It is not wise to allow the pregnancy to proceed to term with a malposition of the fetus or other obstetrical abnormality unrecognized. At this time the obstetrician makes the following observations:

1. The usual blood pressure observation and urine analysis.

2. Abdominal inspection and palpation. The height of the fundus (indicating the probable duration of pregnancy) is observed. The position and presentation of the child is noted. It is important that a breech or transverse position be recognized and that a posterior cephalic position should be detected. The woman should not be allowed to go into labor with an unrecognized abnormality of position.

3. Any peculiarities noted upon palpation which may suggest fetal abnormalities—as anencephalus or hydrocephalus—or the possible presence of a multiple pregnancy are important. These may call for the use of the *x*-ray. The presence of an hydramnion always causes one to suspect a fetal abnormality.

4. The fetal heart tones. Their location and whether they are normal in strength. One does not attempt to predict sex from the rate of the fetal heart.

5. Vaginal examination. This is done gently. One notes: (*a*) Whether the head is floating freely above the pelvic inlet or whether it has entered the pelvis, and if so, to what level.

(*b*) The size of the head, whether normal or larger or smaller than normal. Will this head probably come through this pelvis or not, allowing for the increase in size of the last month?

(*c*) The cervix, effaced or uneffaced, soft or firm. A cervix which earlier in pregnancy may have seemed quite rigid may be found soft and succulent at this time.

(*d*) Any vaginal abnormality. Inflammatory conditions and firm old scars which may interfere with ease of delivery are to be noted.

After this time vaginal examination should not be repeated. Should a pelvic examination be required during the ninth month it should be done rectally. Invasion of the birth canal for any reason during the ninth month should be rigidly restricted. It adds a very definite risk of infection. The sooner labor comes on after such an invasion the greater the risk.

AUTHOR'S SUGGESTIONS TO PREGNANT WOMEN

Introduction.—These notes were not written in order to avoid answering questions but that they might be answered better. Each individual presents a separate case which may require different questions which you should feel free to ask.

and the observations of others show that the fluid arises from the choroid plexus and that hydrocephalus results from obstruction of the aqueduct of Sylvius and the foramen of Monro. This explains the obstruction type of hydrocephalus.

There are various other conditions of the skull, such as the questionable *craniotabes* from rachitis and the "Luckenschädel," where circular areas of membranes persist. Such conditions of the bones naturally predispose to intracranial birth injury.

The skull and vertebral clefts have already been mentioned, and the encephalocele, meningocele, and spina bifida may be of such size as to materially complicate the process of labor and lead to definite dystocia.

The type of monster seen with craniorachitism rarely causes dystocia and is often associated with hydramnion, which may possibly result from an

Fig. 257.—Normal skull. (Specimen from collection of the Göttingen Women's Clinic.)

increased secretion from an exposed choroid plexus. This condition can usually be diagnosed by means of the roentgenogram unless the large amount of fluid interferes with the picture.

There are aplasias, hypoplasias, and hyperplasias with synostosis and supernumerary bones and parts. Sometimes there is a fusion of the lower extremities, which group may be included under the title of *symmelia*. All of the extremities may be absent, which condition is called *amelia*. If only one extremity is lacking the name *ectromelia* is applied. The proximal portion of the extremities may be well developed but the distal part of one or more may be absent or rudimentary, in which type of case the term *hemimelia* is used (Proshek).

A most unusual condition occurs with an aplasia of the proximal portion of the extremity and an attachment of the distal portion to the trunk. Such a malformation is termed *phocomelia*. The roentgenograms of all of these

incidence of unintentional abortions, but such a termination in 20 per cent of all pregnancies would seem to be a low estimate. The figures given are impressive but when one considers the enormous number of intentional abortions taking place at the present day, the wastage of embryonic life seems insignificant. It becomes, however, of great importance to individual mothers and families who are desirous of having children.

In these young embryos, lesser and even unobservable variations from the normal may be the forerunners of serious malformations in later intrauterine life. His indicated that the translucency of embryonic tissues and the visibility of blood vessels, together with well-rounded body curves, speak for the probability of the embryo or fetus being alive at the time of the abortion and for the likelihood of its being normal. Postmortem changes occur very rapidly in these soft and delicate tissues so that prompt fixation is most important. Disease and even death of the embryo does not necessarily result in prompt abortion, and the condition known as "missed abortion" occurs. In this condition it might be well to mention that in the experience of one of the authors women who have repeated early abortion and

Fig. 258.—This is a pathologic embryo 2 mm. long. Menstrual age thirteen weeks.

who might be classed as habitual aborters, not infrequently extrude ova which are distinctly pathologic (Fig. 258).

Mall has estimated the age of his pathologic embryos and is of the opinion that by far the greatest number are formed during the first seven weeks of pregnancy, and that very few occur after the tenth week. The survivors, which should represent about one twelfth of the total, are probably delivered as monsters later in pregnancy.

Parasitic and conjoined twins were also named as types of malformations with skeletal anomalies which could produce dystocia. It is hardly necessary to enter into detailed descriptions of the great variety of these double monsters which are so rarely seen that they almost constitute medical curiosities. Various extremities and portions of the body of one fetus may be attached to an otherwise fairly normal individual. There may be an extra head, supernumerary extremities or additional buttocks. A sort of fetal or teratomatous condition may exist in which one fetus seems to be included within another. There may be incomplete double formation at the upper portion of the body, *diprosopus*; or at the lower part, *dipagus*.

Twins may be united at the cephalad or caudad portions, producing the

bronchioles and alveoli with an admixture of air. This could lead to suffocation from drowning, or to death subsequently from an aspiration pneumonia. In the microscopical examination of the lungs of fetuses which have died postpartum, one not infrequently finds evidence of the aspiration of amniotic fluid containing particles of meconium.

It is easy to understand how interference with the gaseous interchange through compression of the placenta, or cord, could cause fetal death from suffocation. The most characteristic postmortem changes associated with this condition are small petechial hemorrhages, scattered through various organs and noticeable especially on the organs having serous coats. One sees this especially marked in cases in which death is rapid, as occurs with sudden complete detachment of the placenta. It is doubtful if a mature fetus would die from apnea, unless there were some other cause which interfered with the proper functioning of the respiratory center or ventilation of the lungs. A poorly functioning respiratory center could, undoubtedly, cause the death of a premature infant.

Various types of fetal infection occur during labor and during the passage of the fetus through the birth canal. The danger of an aspiration pneumonia has already been mentioned. It is also possible for the fetus to acquire infections of the upper respiratory tract. Infections of the eyes not infrequently occur, as is well known. Various skin and accessory gland infections may result from contamination acquired in passage through the birth canal.

The severance of the umbilical cord may, at times, result in an infection which usually remains localized, but may extend along the umbilical vessels and result in an infected thrombus. This may cause a localized abscess, or a septic process with multiple complicating abscesses.

In association with disturbances of respiration, one has to consider intracranial damage and one dare not longer overlook this probability in the so-called "asphyxiated infant."

The frequency of intracranial injuries in the fetus was not well understood until Beneke established his technic of opening windows in each parietal bone to secure exposure of the brain *in situ* and to visualize the dural membranes after removal of the cerebral hemispheres. By using such a method for opening the cranial cavity, one can demonstrate more readily the best criteria of intracranial injury. The best demonstrable gross evidence is the existence of lacerations of the dural membranes, usually the falx or tentorium, and the presence of hemorrhage. In some cases the injury to the membranes is so extensive and the hemorrhage so great as to be a cause of death. In other instances the degree of tearing is slight and the hemorrhage is minimal. Many such cases recover more or less completely. One must regard these findings as evidence of intracranial damage to brain cells, which it is difficult or impossible to demonstrate unless there is actual gross injury to brain substance. There may be damage to the cerebrum, cerebellum, medulla, and spinal cord, which can be disclosed by opening the vertebral canal.

Birth trauma of the central nervous system constitutes one of the most important phases of fetal pathology, not only because it contributes largely to mortality, but also because of the remote effects in extra-uterine life (Fig. 259). The clinical recognition of these conditions has been obscured by the focusing of too much attention on the syndrome called asphyxia neonatorum. Many of these infants, in whom respiration is established with

There may be simply a localized depression of bone with very little injury to brain substance, or very extensive comminuted fractures with laceration of dural membranes and brain tissue may occur. The mechanism of the production of such injuries is not difficult to understand; they are the result of violence. Similar results occur in other portions of the body, such as fractures of the cervical spine, often with injury to the cord from traction and torsion in efforts to deliver the after-coming head or shoulders. Fractures of the bones of the shoulder girdle and upper and lower extremities, produced by efforts to effect delivery in breech presentations and following versions, also occur.

The mechanism of the production of other intracranial injuries is not so easy to comprehend, especially in view of the fact that they are found following both rapid and prolonged labors, and in those cases which are artificially terminated, as well as in those which are not. Injuries result from short violent labors, also from long hard labors, either with or without operative termination.

Numerous factors enter into the production of intracranial damage. Premature infants are predisposed to such laceration and hemorrhage because of the greater friability of their tissues. There are undoubtedly great individual variations in the resistance of the tissues of mature fetuses. The relationship of the size of the fetal head to the maternal pelvis, the position of the head in the birth canal, the force and duration of the uterine contractions, and, if an operative delivery is made, the skill and technic with which it is performed, all these are very important factors in the production of injuries.

One important factor in the causation of these injuries, in labors not artificially terminated, is compression of the head resulting in head molding. Cranial stress is the resultant of the compressive forces on the head, brought about by the powers of labor and the resistance of the maternal passages. This viewpoint has been well presented by Eardley Holland in a small monograph.

The elongation and other changes in shape of the head which result from prolonged pressure cause tension and stress on the dural membranes and folds which may lead to their laceration, with injury to the neighboring vessels. Tearing of these blood vessels results in hemorrhage, which is more or less extensive. Holland has described stress bands which are to be seen in the falx and converge at its junction with the tentorium. It is in this region that tears usually occur. The vein of Galen and its tributaries, located in this neighborhood, are easily torn when the membranes are ruptured. Holland divides all types of cranial stress into either (*a*) slide, or shearing strain, as illustrated by head molding, and (*b*) stretch, or tension, which results in a break, or tearing, of dural septa. Varying types of cranial stress may result from any kind of delivery through the birth canal, in either cephalic or breech presentation.

Holland considers three points in the structure of the head to be of especial importance: (1) its plasticity, which varies with the degree of ossification of the cranial bones, (2) the attachment of the dural septa to these bones, and (3) the close relation of the septa to blood vascular spaces. The pliability of the skull bones varies greatly in individual infants at maturity, and the premature infants naturally have more plastic skulls. Some impor-

not the important factor in intracranial birth trauma, nor is the most important item the few drops of blood which are frequently found. The most important fact is that these evidences are the best available criteria of brain injury. It is probably true that brain damage occurs in cases with no evidence of lacerations and hemorrhage, though this is difficult to prove. We do know that marked edema of the brain and tissues is frequently found, both with and without lacerations and hemorrhage. Increased intracranial pressure no doubt results from such an edema.

Second, head molding is not the only important factor, as intracranial damage results from cases where the labor has been short and violent, and not associated with head molding, such as is seen in prolonged labors.

Third, depression of the occipital bone produces tension on the dural septa and probably damage to the medulla and cerebellum. Such depression of the occipital bone is apt to occur in vertex presentations with a short anteroposterior diameter of the outlet, also with a rigid perineum, or where vigorous attempts are made to protect the perineum by pressing the head against the pubic arch. Depression of the occipital bone also takes place in breech deliveries, when the occiput is used as a fulcrum and pressed against the pubes for rotation of the after-coming head.

Fourth, it is probable that increased intracranial pressure with engorged vessels and resultant edema can occur from a pumplike kind of action, when the fetus is alternately compressed and relaxed in its longitudinal axis as the result of contractions and relaxations of the uterus.

Fifth, the atypical compressions of the head seen in asynclitism, asymmetrical pelves, breech extractions and operative deliveries are important factors in the production of intracranial injury.

Sixth, one must bear in mind that there is not always equalized pressure of the head. This is illustrated by the localized edema and trauma which occurs on the scalp. Such unequalized pressure, externally, probably has its counterpart within the skull, analogous to that seen in cephalhematoma externa and interna.

It is not always possible to determine the exact cause of fetal death for multiple lesions are often found. Holland found postmortem evidence of intracranial injury in 48 per cent of the fetuses examined.

One of the authors, in a series of slightly more than 1000 fetal autopsies at the University of Minnesota in cooperation with the Department of Pathology, found evidence of traumatic death in 41.8 per cent of the fetuses which were alive at the onset of labor. If one excludes the premature fetuses, birth trauma was the probable pathologic cause of death in 39 per cent and it was thought definitely to be the cause in 31 per cent.

Of approximately 300 cases showing evidence of intracranial birth trauma sufficient to be a cause of death, only the minority were so diagnosed and recorded clinically.

As an addendum to previous remarks regarding asphyxia neonatorum, it is interesting to observe that of 39 cases where the death was clinically assigned to asphyxia 22 were reclassified as deaths from birth trauma after notation of the findings at autopsy.

Other injuries are less frequently the cause of death. The most common, aside from those of the brain and cord, are injuries to the abdominal viscera, especially the liver. One occasionally finds evidence of contusion and hem-

	Per Cent.
Complications of labor	35.5
Antepartum hemorrhage	18.8
Toxemia of pregnancy	11.1
Syphilis	8.7
Maternal states	2.5
Placental states	1.2
Fetal states	10.5
Prematurity	3.6
Cause unknown	8.1

From an analysis of these figures it would seem that half or thereabouts of all fetal deaths are the result of faulty obstetrics, while another one fourth are due to curable diseases of the mother, leaving but one fourth as unpreventable. This brief statement is surely an index of the improvement which must come in the general practice of the obstetrical art.

Deaths before viability are not included in this report, but here again great improvement could be effected by a more widespread knowledge among the laity of the perils to the child from the very onset of pregnancy.

From the series of autopsies collected by one of the authors (Adair) from the University of Minnesota, the following table has been compiled:

	Per Cent.
Birth trauma	38.4
Major anomaly	18.0
Suffocation and aspiration	22.4
Prematurity	6.4
Syphilis	7.4
Other causes	7.4

This series has been mentioned in the text.

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CHAPTER XVII

THE EMBRYOLOGY OF THE FEMALE GENERATIVE TRACT

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INTRODUCTION

If one wishes to become acquainted with the structure and form of any given organ, there is perhaps no better method than to trace its development, step by step, from its embryonic stages. From such a groundwork the significance of its morphology and topography becomes apparent, and furthermore, only in this way can one hope to obtain a basis for the satisfactory explanation of developmental anomalies so often met with in various parts of the body, particularly the female generative tract.

As a result of the large amount of work which has been done on the development of the female generative tract there is a rather general agreement among authors as to the embryology of the fallopian tubes, uterus and cervix, but there is practically no uniformity of opinion as to the development of the sex glands (ovaries) and vagina. There are a number of reasons for this, viz.: (1) Much of the research has been carried out on nonhuman material, on the supposition that development in the human fetus is parallel or identical. A study of comparative embryology points out the dangers of this assumption. (2) Many investigators have reached their conclusions on the basis of studies of congenital anomalies in this region. It is obvious that theories of development based on such evidence are satisfactory only when the conclusions are borne out by studies of normal embryological development. (3) It is also true that many of the theories must be the result of study of poor and scanty material, without recourse to the use of adequate reconstructions or plots. This, of course, permits of great breadth of interpretation and accounts for some of the diametrically opposed theories.

In the following pages I shall present, in their successive stages, in so far as possible, the development of the internal and external female genitalia, stating the controversial points whenever feasible.

The urinary and reproductive tracts, despite their different functions, are so mutually interrelated during development that a joint consideration of their early embryology is necessary for the sake of clarity. For example, in very early stages both urinary and reproductive tracts open into the cloaca, the enlarged caudal portion of the digestive tract. The cloaca later becomes subdivided into a ventral channel which eventually forms the bladder, the urethra, the lower portion of the vagina and the urogenital sinus; and a dorsal channel which forms the rectum. Again, the mesonephros and wolffian duct unite with the testis to form its excretory system, while in the female the former remains as a vestige in the hilum of the ovary. The urinary and reproductive organs must, therefore, in the early stages, be considered together.

of 5.7 mm. (Politzer, 1931; Keibel, 1896). The principal tubules of the various segments do not appear simultaneously but are formed in successive groups, the cranial ones first, and then the caudal ones. Once the collecting duct and

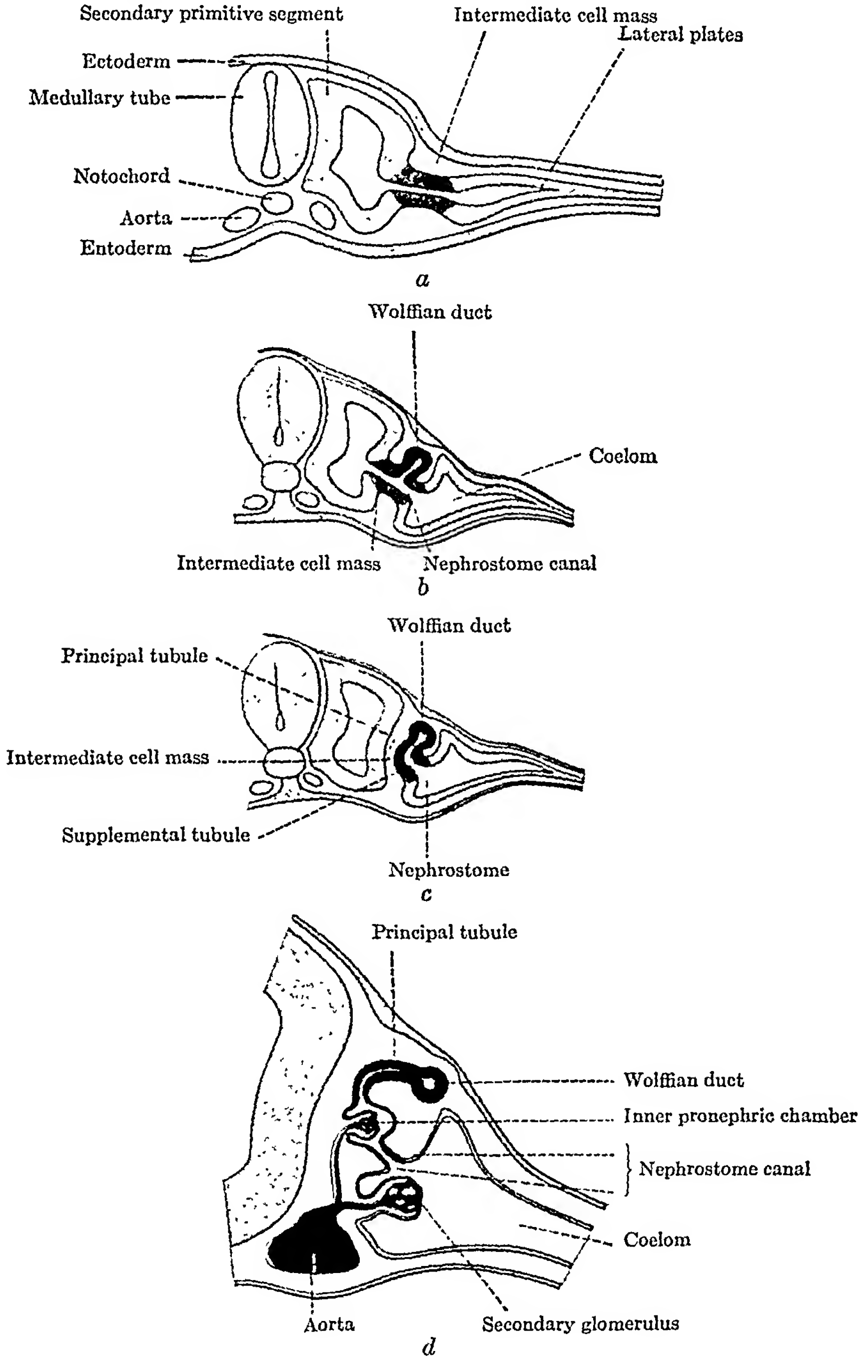

Fig. 260.—Diagram illustrating the development of a pronephric segment. (After Felix.)

principal tubules are formed, a further differentiation of the intermediate cell mass begins. In Fig. 260, *c*, the secondary primitive segment separates from the intermediate cell mass, which closes laterally and forms a connecting

plate and, as recorded above, empties into the coelom. The broad part is called the *inner pronephric chamber*, and the narrow one the *nephrostome canal*. Another vascular glomerulus projects on the visceral layer of the lateral plate close to the opening of the nephrostome canal into the body cavity. These are termed "internal" and "external glomeruli"; the latter are independent structures not related to the pronephric tubules. Thus the pronephros is formed, the glandular portion appearing when the embryo is 1.75 mm. in length, reaching final development at 2.5 mm. The cranial portion undergoes atrophy, and the entire pronephros completely degenerates at 4.9 mm.

Mesonephros.—The mesonephros begins to develop at approximately a 2.5 mm. stage, that is, after the pronephros has reached full development. On the medial side of the wolffian duct and extending from the sixth cervical to the third lumbar vertebra a longitudinal thickening of the mesoderm

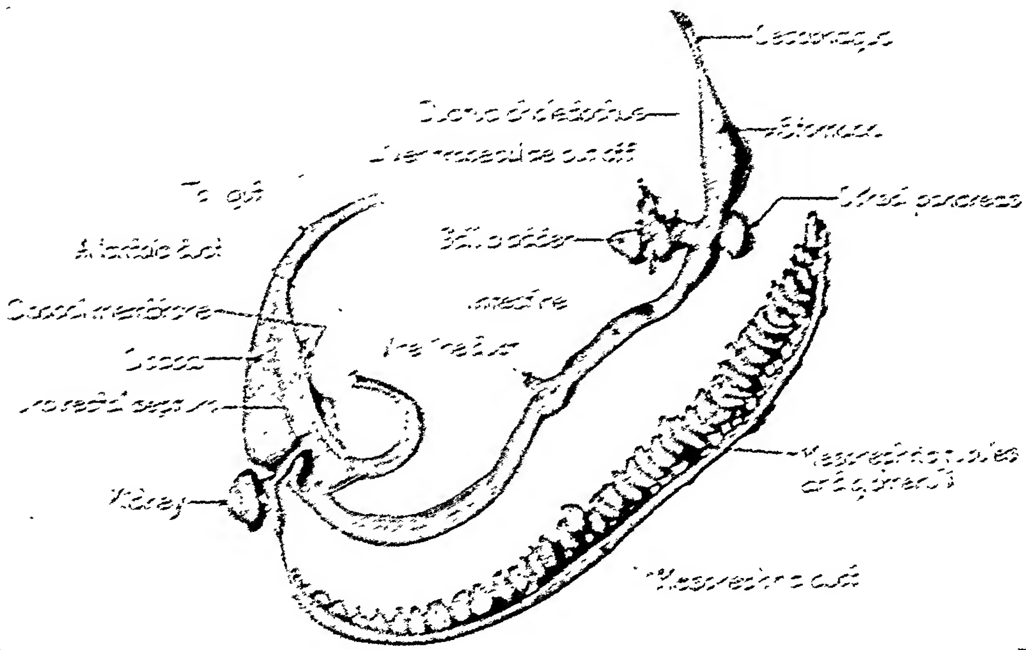

Fig. 212.—Schematic projection from a reconstruction model of the excretory details of the mesonephros, together with the alimentary canal, of a human embryo. (F. Kollmann, Contributions to Embryology, vol. ii,

appears. This is termed the *mesonephrogenic cord* from which some eighty *mesonephric tubules* (Kollmann, 1898; Felix, 1912) develop in the same manner as those of the pronephros, and from the same parent tissue, the intermediate cell mass. Each tubule first appears as a solid proliferation of the intermediate cell mass, which later becomes hollowed in the center to form a vesicle; one end grows laterally towards the wolffian duct and finally opens into it. The opposite end dilates, its epithelial wall becomes thin, and finally is invaginated by a tuft of capillaries to form a glomerulus. Once the connection with the wolffian duct is established and the malpighian corpuscle is formed, the tubule lengthens, begins to bend, and finally assumes an S shape. Of the three limbs or transverse portions of the S the most ventral one (distal to the wolffian duct) becomes the glomerulus or malpighian corpuscle; from the common limb or middle portion is formed the secretory tubule and from the dorsal limb

thirty pairs of mesonephric tubules and glomeruli. At the caudal portion of the mesonephros the undifferentiated mesonephrogenic cord is present. The wolffian duct is situated lateral to the mesonephros and, receiving the collecting tubules of the latter in series, empties into the ventrolateral portion of the cloaca.

Figure 263, from a 23-mm. human embryo, shows the early degeneration of the cranial and the development of the caudal tubules of the mesonephros. It is noteworthy that the caudal tubules are closely compressed together, and in fact some of the collecting ducts fuse so that one may become the efferent for several secretory tubules. This may explain the origin of the duct

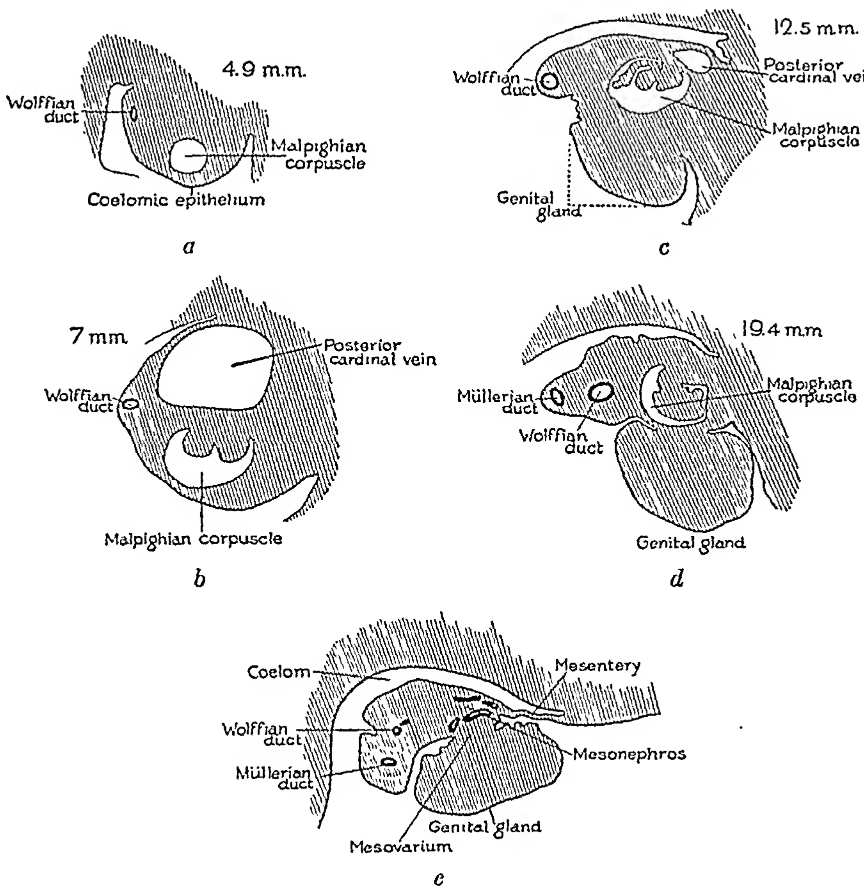

Fig. 264.—A series of diagrams in cross section to illustrate the development of the urogenital fold in the female.

of Haller, so often seen in the adult, since eight to ten glomeruli and secreting tubules of the caudal portion often become separated from the wolffian duct, emptying into the latter by one, three or four collecting ducts.

The changes in the relation of the caudal tubules to the wolffian duct make possible a division of the mesonephros into a caudal and a cranial portion. The cranial portion unites with the reproductive gland and becomes the epoophoron in the female and the epididymis in the male. The caudal portion undergoes partial involution and becomes the paroophoron in the female and the paradidymis in the male.

Thus the urogenital fold is divided into two portions. One contains the müllerian duct (lateral), the wolffian duct, and the mesonephros, and the other contains the genital gland (Fig. 264, *e*). The former is called the *mesonephric fold,* the latter the *genital fold.* The mesonephric fold becomes further divided into a portion containing the müllerian duct, and one containing the wolffian duct and mesonephros. This division occurs only in females at about a 13-mm. stage.

A change in the course of the urogenital folds also occurs. Originally both folds lie parallel to the vertebral column, but, as soon as the suprarenals and kidneys begin to grow, they displace the folds laterally. Caudal to the permanent kidneys, however, the pressure ceases, and in this region the two urogenital folds are not displaced. The occurrence of the displacement above, and its absence below, produces a double bend in the fold just below

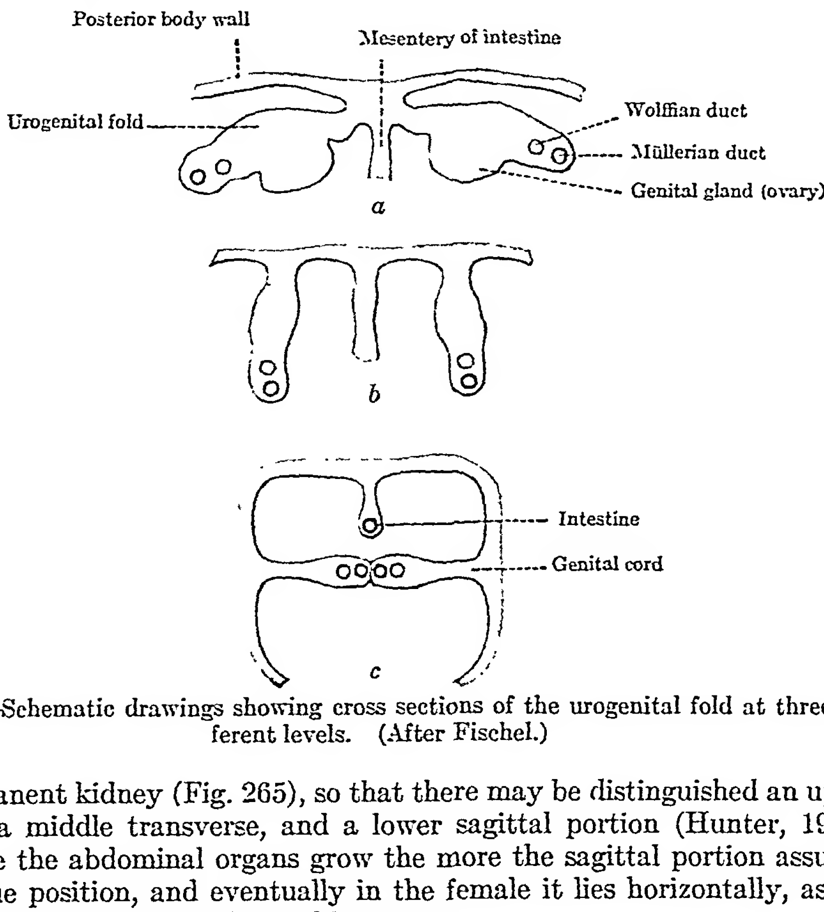

Fig. 266.—Schematic drawings showing cross sections of the urogenital fold at three different levels. (After Fischel.)

the permanent kidney (Fig. 265), so that there may be distinguished an upper sagittal, a middle transverse, and a lower sagittal portion (Hunter, 1930). The more the abdominal organs grow the more the sagittal portion assumes an oblique position, and eventually in the female it lies horizontally, as the fallopian tubes, ovaries and broad ligaments.

The caudal sagittal portion of the folds on each side come together and fuse to form a frontal partition which divides the pelvis into a ventral and dorsal half. The fused caudal sagittal portions of the urogenital folds are termed the *genital cord.* Figure 266, *a*, *b*, *c*, shows three transverse sections through the lower portions of both urogenital folds at different levels. The upper (*a*) shows the mesonephric and genital folds separated, the portion containing the müllerian ducts directed laterally; in the middle level (*b*) the mesonephric folds are nearer together, the müllerian portion directed anteriorly;

of the fallopian tube. Except for the cranial extremity the lips of the müllerian groove fuse and separate from the coelom to form a tube, the tip of which is made up of a solid mass of cells which burrow caudally like a root hair through the mesenchyme of the urogenital fold. As the solid tip extends caudally the lumen is forming a short distance behind. Figure 267, *a* and *b*, shows graphic representations of coronal views of the müllerian and wolffian ducts. The position of the müllerian ducts is quite characteristic. They lie at first in the extreme lateral portion of the urogenital fold, necessarily lateral and somewhat ventral to the wolffian ducts. At the caudal extremity of the mesonephros, they bend medially, cross the wolffian ducts anteriorly, approach each other in the midline, and extend caudally to the posterior wall of the urogenital sinus, which is pushed forward to form a hillock termed the *müllerian tubercle* (Fig. 268). As the ducts grow caudally fusion takes place, the septum disappears in a caudocranial direction, and a single tube is formed, designated as the *uterovaginal canal* (Fig. 267, *b*). The failure to fuse of the paired müllerian ducts leads to the formation of numerous congenital malformations of the uterus and vagina.

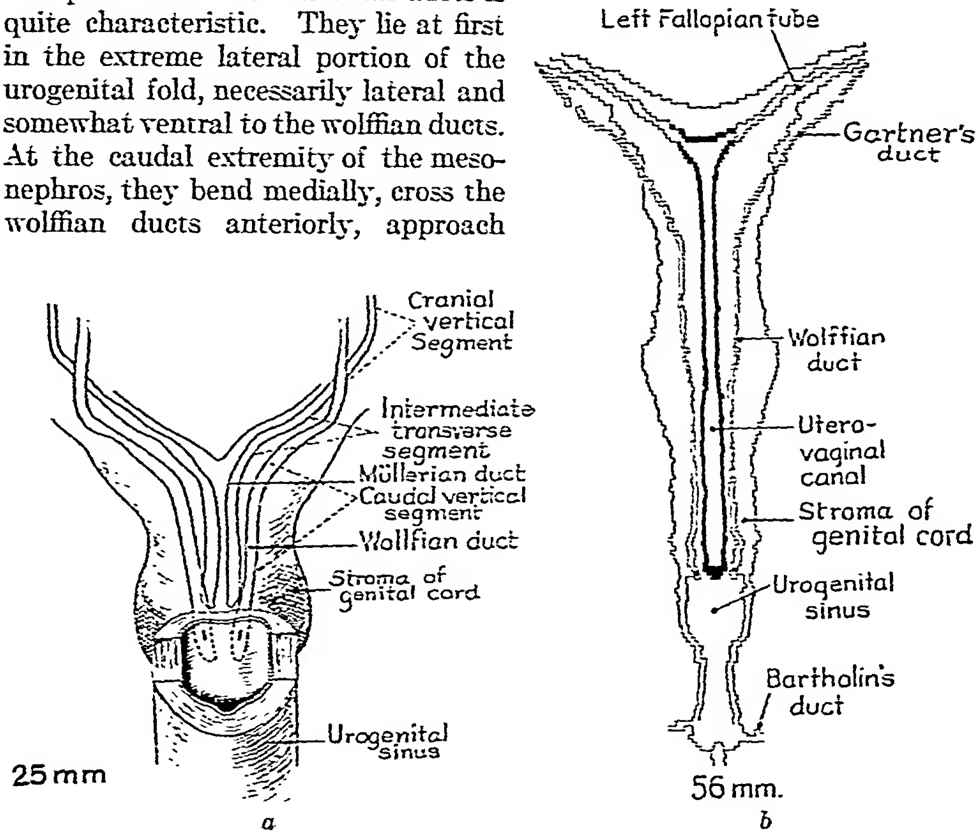

Fig. 267.—*a*, A coronal view of the relations of the müllerian and wolffian ducts to each other and to the urogenital sinus. The wolffian ducts open into the latter. The müllerian ducts cranially lie lateral to the wolffian but at the level of the caudal extremity of the mesonephros cross ventrally (intermediate transverse segment), approach each other and come to lie medially (caudal vertical segment). The outlines surrounding the ducts mark the limits of the condensation of mesenchyma of the genital cord.

b, A coronal view of both urogenital sinus and genital cord. The wolffian ducts are relatively small and have lost their openings into the urogenital sinus. The müllerian ducts have fused to form the single uterovaginal canal. The pelvic portion of the urogenital sinus at its junction with the phallic portion is marked by Bartholin's glands. The wolffian ducts leave the genital cord to enter the broad ligaments and are then termed Gärtner's ducts. (Koff in Contributions to Embryology, vol. 23, Carnegie Institution of Washington.)

the mesonephros. The end of the tube never quite reaches the cranial extremity of the ovary, and always projects beyond it even in the adult.

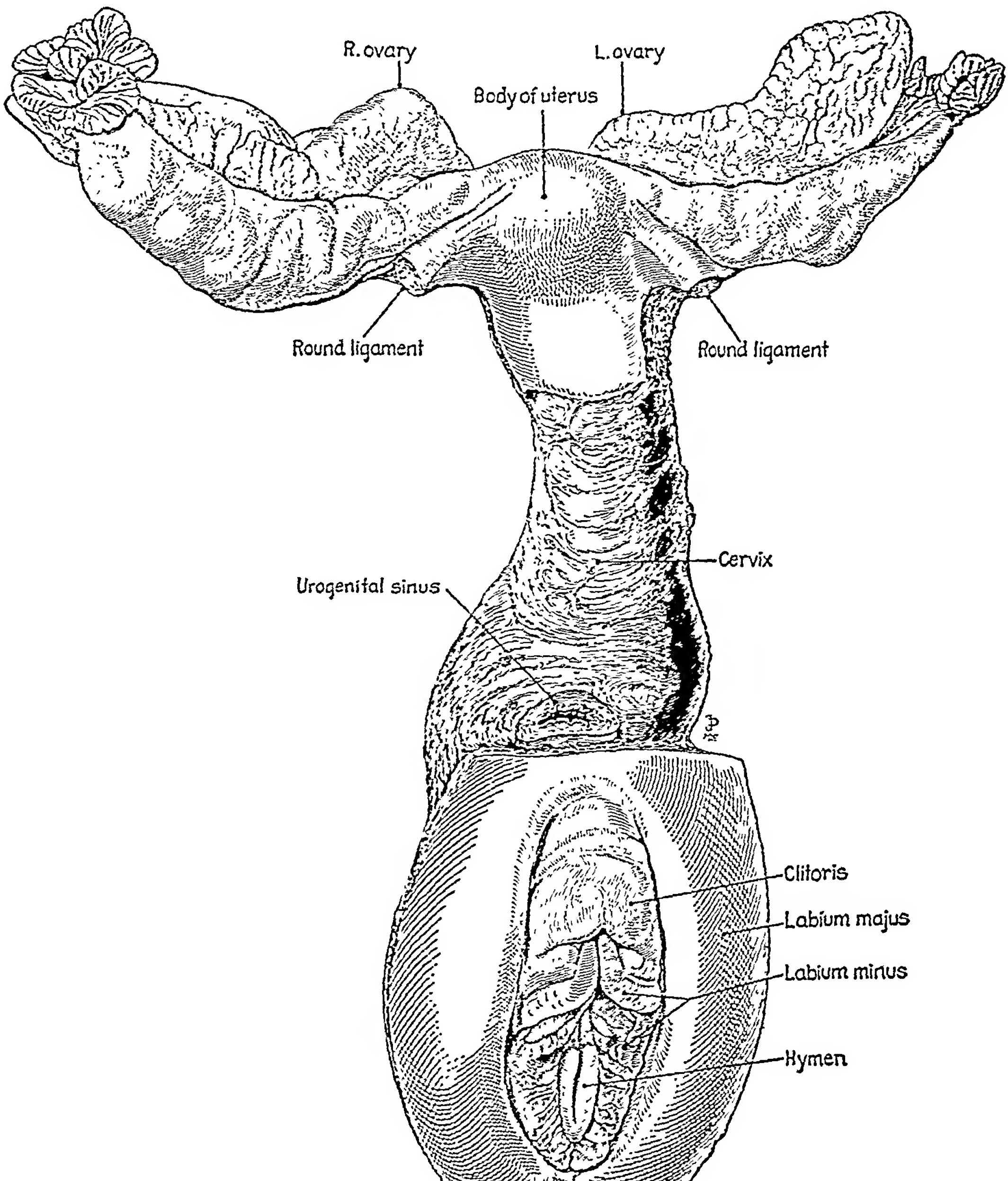

Fig. 269.—Dissection of the female genital tract of a 227-mm. human embryo. The fallopian tubes are seen through folds of peritoneum in closely arranged coils. The fundus of the uterus is already developed. (R. H. Hunter, Contributions to Embryology, vol. 22.)

At 36 mm. the cranial vertical portions of the müllerian ducts begin to show tortuosity, and this continues to increase slowly until a 227-mm. stage (Fig. 269), when they rapidly increase in length. Since they are enclosed

the size of the uterine cavity cranially. In Fig. 269, the fundus is seen to be curved outward to increase further the cavity of the uterus and give it triangular form by incorporating the horizontal portions of the müllerian ducts. Here the round ligaments appear to come into relation with the uterine wall, due to the broadening of the uterus and incorporation of the horizontal or uterine portions of the tubes, to the cranial or lateral portions of which the ligaments were attached. How much of the later uterine mucous membrane is formed from the horizontal portions of the tubes, and how much from the uterovaginal canal cannot be stated, since there is no difference in type of epithelia, at this stage, both being columnar.

DEVELOPMENT OF THE CERVIX

The cervical portion of the uterovaginal canal first appears in transverse sections as a tiny circle lined with cuboidal epithelium. As growth progresses the circle elongates in a lateral plane to form a transverse oval. By a process of irregular growth the epithelial walls of the oval become folded upon each other to form a transverse slit somewhat like the letter W. Secondary longitudinal folds arise. As the accessory folds appear, the uterine body and cervix elongate and the folds become somewhat flattened in the uterine cavity, but not in the cervix. Transverse folds are then added to these longitudinal ones and as a result broad swellings are formed which project into the lumen of the cervix so as almost to fill it. When this occurs the folds assume an oblique direction, in an effort to accommodate themselves to available space. These obliquely placed folds are developed at a 160-mm. stage (Hunter, 1930), and are the forerunners of the *plicae palmatae*. These changes result in an enormous increase both in length and width of the cervix, which rapidly assumes a large size in relation to the body of the uterus (Fig. 273) quite different from that seen in the normal nonpregnant uterus of the adult.

These growth changes are of considerable interest when compared with the enlargement of the cervix in the pregnant uterus described by Stieve, in 1927, and with the growth in length of the fetal uterus described by Scammon in 1926. In supporting the work of Halban, 1905, Scammon drew attention to the fact that if a chart be made of the length of the fetal uterus at different stages of development, it is seen that immediately after birth the growth makes a sudden drop. This is said to be due to the sudden withdrawal from the fetus of placental or maternal hypophyseal hormones. Scammon pointed out that if the line of growth before the enlargement is projected on to the line of growth after reduction in length at birth, this line will show that the length of the uterus after birth is just as would be expected if growth had been uniform throughout the whole period. Hunter (1930) measured a large series of gross dissections of the uterus and confirmed Scammon's observation. He found, however, that the sudden reduction in length after birth is associated mainly with a decrease in size of the cervix.

Similar enlargement of the cervix has been shown by Stieve (1927) to occur in the pregnant uterus. This writer believes that the cervical swelling is probably due to hormones that develop in pregnancy. The epithelial cells are stimulated to activity, undergo hyperplasia and secrete an enormous amount of mucin. This, in turn, causes degeneration of the cells themselves. The degenerated cells are then shed and a denuded surface is left. The extraordinary enlargement of the fetal cervix prior to birth is probably due to

vagina becomes sharply demarcated by the formation of the solid primordia of the anterior and posterior fornices in the form of solid shovel-shaped epithelial projections. The anterior is lower than the posterior fornix developmentally, and not because of the uterovaginal angulation, as usually stated (Fig. 275).

The primitive vaginal plate increases in all dimensions, especially anteroposteriorly, by a sudden phase of epithelial proliferation

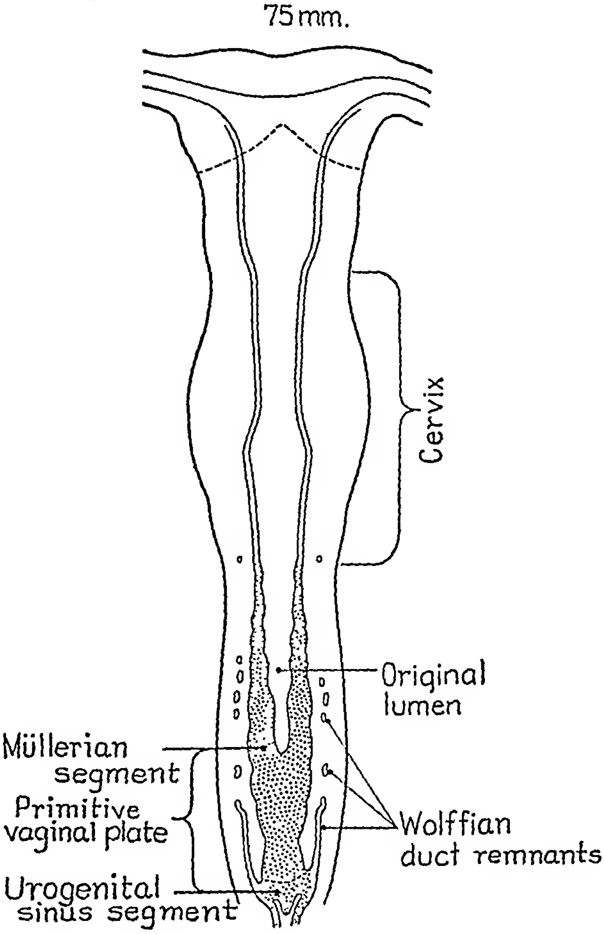

Fig. 273.—The stippled area represents the caudal portion of the uterovaginal canal and the sinovaginal bulbs converted into a solid mass of epithelium (primitive vaginal plate). The stratification of epithelium progresses cranialward. The wolffian ducts are intact at the very caudal end but have generally involuted to such an extent that only slands of epitheluim remain on each side of the primitive vaginal plate. (Koff in Carnegie Institution of Washington, Department of Embryology, vol. 23.)

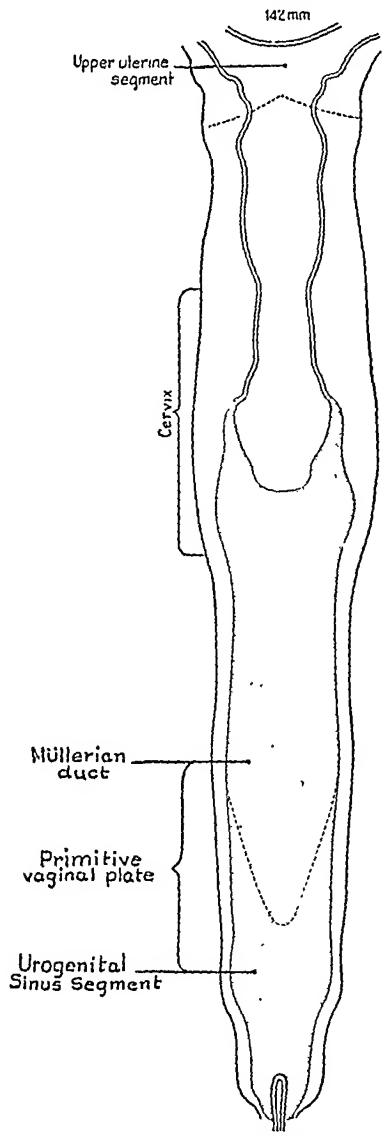

Fig. 274.—The caudal portion of the uterovaginal canal has become solidified by stratification and fusion of the epithelium of the müllerian ducts, and sinovaginal bulbs forming the primitive vaginal plate. This solidified portion later hollows out to form the vagina. (Koff in Contributions to Embryology, vol. 23, Carnegie Institution of Washington.)

and invasion of the surrounding mesenchyme, like the growth of a cancer (Fig. 276). The epithelial activity begins at the caudal extremity and proceeds cranially. The growth in length and width of the caudal end of the

It is thus seen that the vagina has a double origin from the caudal portion of the uterovaginal canal (müllerian, upper two thirds) and the sinovaginal bulbs (urogenital sinus, lower third).

On the basis of his study of a large series of human female embryos, from 11 mm. C. R. length to term, Nagel (1889–91) came to the conclusion that the vagina and hymen are purely müllerian in origin. He states that these structures arise wholly from the united müllerian ducts. The lower ends become solid, grow rapidly in length through hypertrophy and hyperplasia of their lining cells and invaginate the posterior wall of the urogenital sinus to form the müllerian tubercle. The apex of this projection breaks down to allow communication between the vagina and the sinus, thus marking the origin of the future hymenal orifice—in the position of the müllerian tubercle of

Fig. 276.—This is a photograph of a transverse section through the primitive vaginal plate a short distance above its contact with the urogenital sinus, of a 155-mm. embryo. Three centers of proliferation are shown; two lateral with degenerating cells to form the vaginal lumen, and one central. The urethra is shown anterior to the vagina. (Koff in Contributions to Embryology, vol. 23, Carnegie Institution of Washington.)

earlier specimens. The solid lower portions of the fused müllerian ducts eventually hollow out to form the vagina and the upper patent portions become the canal of the cervix and the cavity of the uterus. Exactly this theory has been stated in most of the German and English text-books, *e. g.*, Keibel and Mall (1912), Prentiss and Arey (1920) despite the contradictory evidence to be presented later.

Bloomfield and Fraser in 1927, after a study of this problem, summarized their results as follows: "The lower end of the vagina, like the rest of that structure, is purely a müllerian derivative. It establishes connection with the urogenital sinus at an early stage at the apex of the müllerian tubercle. This site is that of the upper part of the future hymen. Its lumen is filled for a short time with a plug of epithelial cells derived from the lining of the

Mijsberg (1924) and Kemperman (1931) came to the conclusion that the upper two thirds of the vagina is müllerian in origin while the lower third is formed by the fusion of the wolffian bulbs with each other, the uterovaginal canal above and the urogenital sinus below. Mijsberg states, "In the middle of the third month they (wolffian bulbs) appear as vesicular dilatations of the lower ends of the wolffian ducts. Even in their early stages their epithelial walls are fused with the epithelium of the urogenital sinus: The lumen of the vesicles soon disappears by the marked thickening of the stratified cuboidal epithelium, and the wolffian bulbs are formed. These proliferate quite rapidly and extend a certain distance along the lateral walls of the urogenital sinus *so that they include part of the sinus.*" Except for different terminology this description would hold for the sinovaginal bulbs described by Koff (1932). Mijsberg, however, does not recognize that the intimate connection of the so-called "wolffian bulbs" with the urogenital sinus is due to the fact that they are not wolffian in origin, but derived from the urogenital sinus. Evidence for this is as follows: In early stages the epithelium lining the bulbs is identical with that lining the urogenital sinus; the cells lining the wolffian ducts never show signs of proliferation and, in fact, show evidence of degeneration; in a number of specimens the wolffian ducts completely disappear before the bulbs are formed; the urogenital sinus presents lateral evaginations coincident with the disappearance of the müllerian tubercle. If the bulbs were derived from the wolffian ducts one would expect a pushing forward of the posterior wall of the sinus rather than a pulling outward as can be seen in Fig. 270. It is, moreover, unreasonable from the point of view of general embryology to expect the wolffian system to involute generally while the lower ends suddenly assume a period of activity and play so important a rôle in the formation of the vagina.

Retterer (1891) states that the vagina is formed in part from the fused müllerian ducts and in part from the urogenital sinus. He describes lateral folds in the urogenital sinus which thicken, approach each other, and fuse. The urogenital sinus is thus divided into an anterior canal which serves as the urethra, and a posterior channel which forms the sinus derivative of the vagina. The criticism of this theory, as agreed upon by most recent investigators, is that at no time is there evidence of fusion of folds in the urogenital sinus of human embryos.

Spuler (1930), writing in Veit-Stoeckel's "Handbuch der Gynäkologie," states that the vagina is mainly müllerian in origin, and believes that the lower fused ends of the müllerian ducts, which he calls the *conus vaginalis,* derive cells from the urogenital sinus. He also believes that the lower portion of the vagina develops as a frontal division of the urogenital sinus, a view similar to that of Retterer.

An analysis of both Spuler's and Retterer's views shows that they believe the lower portion of the vagina to be formed from the urogenital sinus. But they also believe that the mode of formation depends upon a frontal separation of the urogenital sinus by fusion of lateral folds therein.

Pozzi (1884) also believes that the lower portion of the vagina is derived from the urogenital sinus. His belief is based on a study of abnormalities of the vagina and vulva, particularly on a case in which the hymen was present and the vagina was represented by a small pocket which he believes was derived from the urogenital sinus as well as the hymen. Wharton (1929)

Taussig (1908) bases his views on a study of five embryos examined by serial section and considers that the hymen has a vaginal origin, independent of the point at which the vagina is in contact with the urogenital sinus. Within the vagina, according to this author, there arises a fold of vaginal tissue, the hymen. At the point where the vagina is continuous with the sinus epithelium, another well-marked fold of tissue is present which disappears as development proceeds.

Gellhorn (1904), Nagel (1891), Buden (1879) agree that the hymen has a dual origin, namely, from the müllerian ducts and urogenital sinus. Mijsberg (1921) and Kemperman (1931) also ascribe to the hymen a dual origin, from the wolffian ducts which they believe form the lower portion of the vagina, and the adjacent urogenital sinus. It follows, therefore, that theories concerning the formation of the hymen are dependent on those concerning the origin of the lower end of the vagina.

DEVELOPMENT OF THE UROGENITAL SINUS

The rectum, bladder, urethra, and urogenital sinus are formed by a triple division of the cloaca. The first division completely separates the dorsal third of the cloaca or the rectum, and the remains of the cloaca are divided by a second incomplete division into the bladder, urethra, and urogenital sinus.

By cloaca is understood that part of the intestine that lies caudal to the point where the allantoic duct projects. Into it there open from above, the intestine and the allantoic duct (Fig. 262). The ventral surface of the cloaca comes into contact and fuses with the ectoderm on the surface of the body, the mesoderm being pressed aside. This area of fusion is termed the *cloacal membrane* (Tourneut, 1888; Born, 1894; Politzer, 1931). The cloacal membrane consists then of two layers of epithelium, externally ectoderm, internally entoderm. In Fig. 262 the membrane begins immediately caudal to the allantoic duct and extends almost to the caudal end of the cloaca.

The first division of the cloaca begins in 4-mm. embryos. It separates the dorsal third or quarter, the rectum, from the ventral portion of the cloaca. The separation takes place by the formation of the saddle between the opening of the allantois and intestine into the cloaca, growing as a frontal partition parallel to the dorsal wall. This is termed the *urorectal septum* (Fig. 262). The line along which the septum grows downward in the interior is marked on the outer surface of the cloaca by a groove. The septum eventually reaches the cloacal membrane, fuses with it and divides the cloaca into the rectum, and the ventral remains of the cloaca (Fig. 263). By this fusion the cloacal membrane is divided into an anal membrane that closes the rectum, and a urogenital membrane that closes the ventral remains of the cloaca. In later development both membranes are broken through independently to form the urogenital and anal openings.

While the urorectal septum is growing, the second division, which separates the ventral remains of the cloaca into bladder, urethra, and urogenital sinus, is beginning. The cloaca is fastened to the outer wall of the body of the embryo at three points; to the umbilicus by the allantoic duct or urachus, along the entire cloacal membrane to the anterior abdominal wall, and by the mesonephric or wolffian duct to the posterior wall of the embryo. The position of these three points of fixation determines the shape of the cloaca.

as labor advances and a lower, passive segment which becomes thinner and larger. As long as the membranes are intact the forces of the contracting uterus are applied to the fetus through the amniotic fluid, and therefore are of equal intensity in all directions. Since the lower uterine segment and

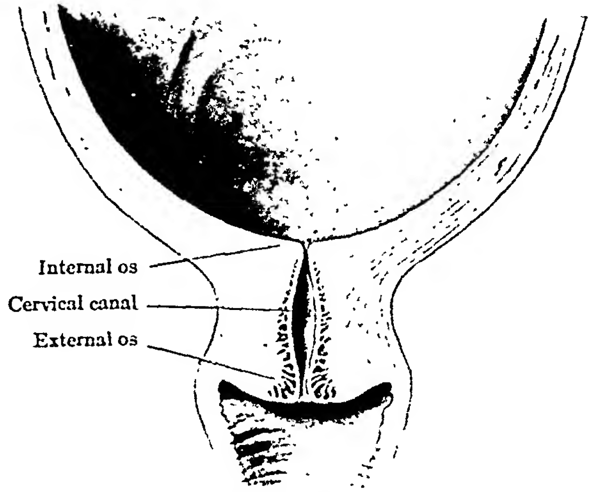

Fig. 362.—Cervix of a primipara at the beginning of labor. (Bumm.)

cervix are pierced by canals they form the area of least resistance. Stieve[47] has shown that early in labor the fetal membranes in the region of the lower uterine segment become separated and are forced into the cervical canal by the contractions of the uterus. This causes early expulsion of the cervical mucous plug which carries with it almost all of the hypertrophied glands of

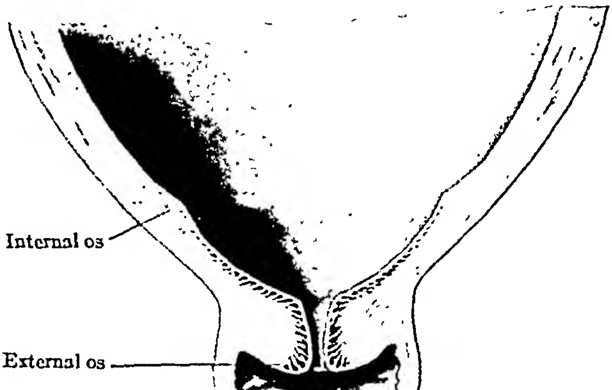

Fig. 363.—Cervix of a primipara during first stage of labor. Partial obliteration of canal. (Bumm.)

the cervix and some of the blood from the dilated cervical vessels. Thus, a relatively wide area of cervix is early exposed to the hydrostatic action of the enclosed amniotic fluid, or in the case of premature rupture of the membranes, to that of the presenting part.

changes, however, are those involved in the separation of the urogenital opening and the anus. In the male the gutter-like urogenital opening is transformed into the tubular urethra by the almost complete fusion of the bilateral urethral folds to form the median raphe (Fig. 279, A). At the same time the labioscrotal swellings migrate from their primitive lateral position to a new one caudal to the penis, forming the scrotum. In the female the labioscrotal swellings unite caudally in front of the anus to form the posterior commissure and persist as the labia majora (Fig. 279, B). The urethral folds which fuse in the male remain open in the female to surround the urogenital opening (urethrovaginal orifice) and form the labia minora (Fig. 280). The cavernous portion of the phallus becomes the clitoris, divided by the coronary sulcus into glans and shaft, the latter continuous with the labia minora until the frenulum clitoridis develops at a somewhat later period. In the male the prepuce develops at about 10 mm. in the following manner. The primitive glans becomes divided into two portions by an epithelial cylinder that grows in from the epithelium of the external surface. The two parts are an outer cylindrical mantle, forming the prepuce, and an inner sphere, forming the glans. The epithelial ingrowth or lamella is not a closed tube, but is imperfect on the anal surface, where the stroma of the glans and prepuce form the frenulum. The solid epithelial lamella becomes hollowed out by degeneration of its central cells, the cavity breaks through to the exterior, and there the space between glans and prepuce is formed. In the same general way the prepuce and the frenulum develop in the female.

THE DEVELOPMENT OF THE OVARY

The Problem of the Origin of the Germ Cells.—Since the time when August Weisman (1904) first made a clear distinction between the soma and the germ plasm, and introduced the now familiar concept of the uniqueness and continuity of the germ cells, the origin and history of definitive germ cells have become subjects of controversy.

Boveri, in 1892, confirmed Weisman's theory by his work on the parasitic round-worm (Ascaris) in which it seemed that germ cells could be traced back definitely to early segmentation stages. According to this interpretation a part of the original fertilized egg is set apart as germ plasm early in cleavage, a single cell of the four-celled embryo in the case of Ascaris. Work on the history of the vertebrate germ cells dates back to Waldeyer (1870), who first observed distinguishable germ cells in the germinal epithelium from which he supposed them to have been derived. Hoffman in 1886 and Dustin in 1907 confirmed Waldeyer's theory of origin from the germinal epithelium and Gatenby (1916) added experimental evidence along the same line. However, Beard (1900) and B. M. Allen (1906, 1911) upheld the early segregation theory of Weisman.

Waldeyer's observations of recognizably different cells in the germinal epithelium, together with the evidence of other workers for the early segregation theory, suggested the possibility of tracing the so-called "primordial germ cells," and following their migration in the developing embryo until they reached the site of the gonad. Jenkinson (1913) described primordial germ cells migrating from the yolk sac, where they form, to the genital ridge; but he admitted the possibility of a peritoneal origin for some of the germ cells. Fuss (1911, 1913), upon the basis of Rubaschkin's (1908, 1910)

The Indifferent Stage.—The indifferent reproductive gland appears within the urogenital folds along with the mesonephros, wolffian and müllerian ducts previously described. A small strip of the epithelium of the genital fold, derived from the coelomic epithelium medial to the mesonephros, forms the parent tissue of the reproductive gland. The epithelium of the urogenital fold usually consists of two layers of flat cells. In embryos of 5.3 to 7 mm.

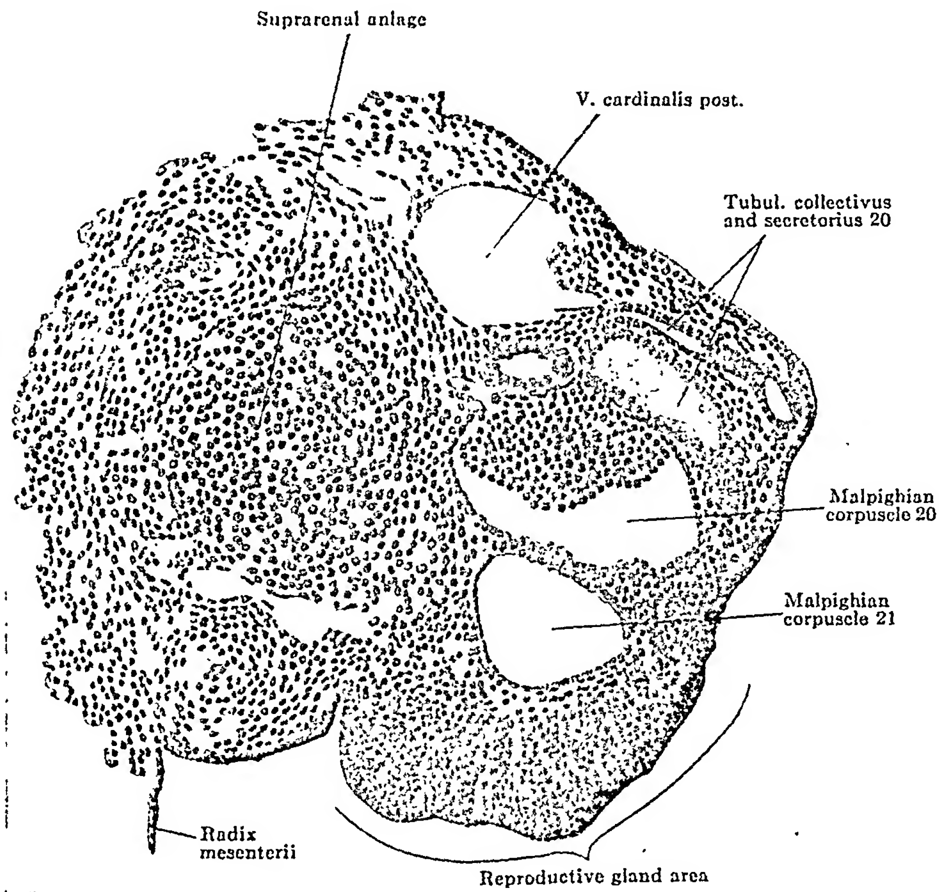

Fig. 281.—Transverse section of the urogenital fold of a human embryo of 11 mm. greatest length, 9 mm. head-foot length. (Embryo P. 1, from the collection of Professor Hochstetter, Vienna; × 150.) Almost all the parts of a mesonephric tubule are cut. Medial to the tubule is the suprarenal anlage; the mesonephric fold lies in the frontal plane, its summit is marked by the primary excretory or wolffian duct and a dorsolateral and a ventral surface may be distinguished. At about the middle of the ventral surface is the thickening of the peritoneal epithelium which forms the reproductive gland area. This consists solely of coelomic epithelial cells, which are becoming somewhat loosely arranged. No differentiation whatever of the epithelial mass is to be seen.

the coelomic or peritoneal epithelium on the medial surface of the urogenital fold and extending along its entire length becomes many layered, invades the mesenchyme of the latter, and eventually forms a solid mass of cells showing numerous mitotic figures. Soon lateral and medial grooves appear in the urogenital fold (Fig. 264, *c* and *d*), separating the reproductive gland from the mesonephros, wolffian, and müllerian ducts. However, the genital cells come into close contact with the malpighian corpuscles of the mesonephros at the

surface epithelium. There are eventually two types of cells in the epithelial cell mass, *genital cells* and *indifferent cells*. The former are distinguishable by the large size of their cell bodies and nuclei, the cell body being about twenty-seven times the size of the nucleus. The latter are vesicular in shape and contain a wide-meshed chromatin network.

Between 28 and 80 mm. two changes occur in the epithelial cell mass: (1) The ingrowth of connective tissue and vessels from the hilum to the periphery;

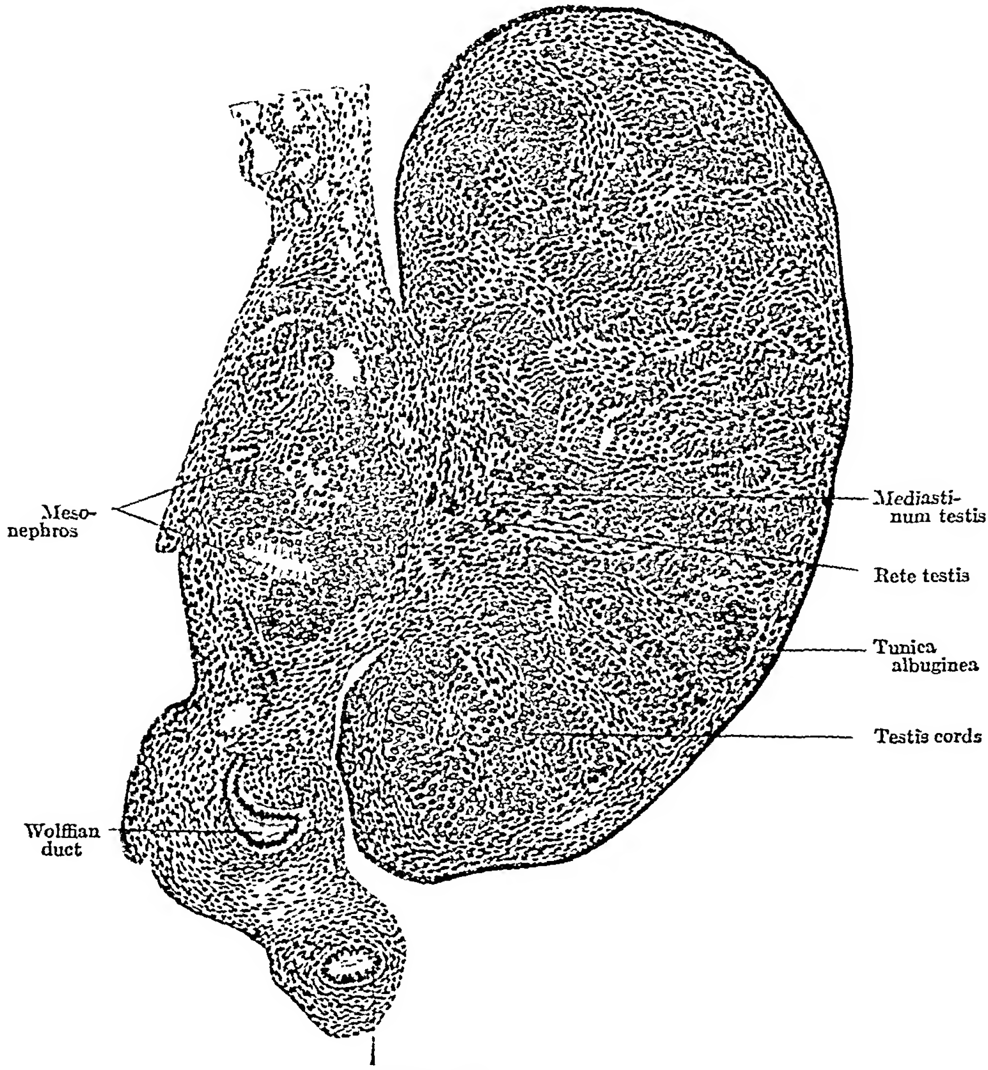

Fig. 282.—Cross section through the testis and mesonephros of a 20-mm. human embryo. (*After Fischel.*)

(2) the conversion of most of the genital and indifferent cells into young ova and follicle cells (Felix, 1912). The first traces of connective tissue are seen in 28-mm. embryos. Fine strands, which develop branches, radiate from the hilum to the surface of the ovary, so that a network is formed which has coarse meshes in the medullary zone and fine ones in the cortical zone. Moreover, numerous strands reach the surface of the ovary to form a compact layer, the *tunica albuginea*, which is fully developed at 180 mm. Thus the

genital and indifferent cells become subdivided by the stroma into small groups (Fig. 283). Each group contains a primordial ovum surrounded by a layer of follicle cells, both derived from the genital and indifferent cells. Each primordial ovum, surrounded by a layer of follicle cells, is called a *primary follicle* (Fig. 284).

From the third month of development those cells included in the coarse meshes of the medulla degenerate, and the connective tissue strands collapse to form the dense stroma ovarii. So it is only in the peripheral or cortical portion of the ovary that follicles persist.

The primordial follicles may develop into graafian follicles at any time during intra-uterine life, after the sixth month. In fact, their number increases as pregnancy advances, despite the fact that involution occurs concomitantly, as indicated by the presence of atretic follicles in the fetal ovary. It is the general assumption that the number of primary follicles increases

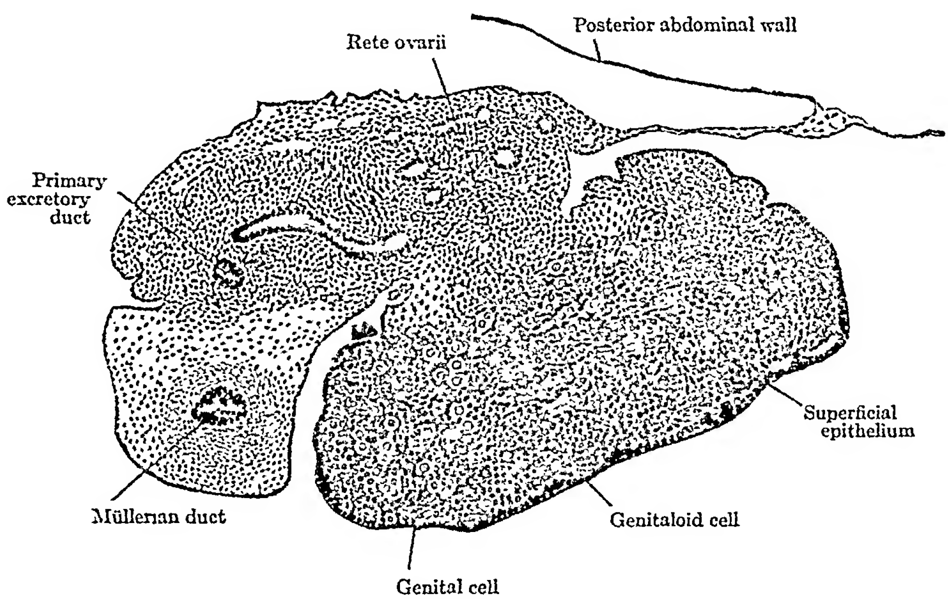

Fig. 285.—Transverse section of a 50-mm. human embryo showing relation of ovary and rete ovarii to mesonephros and müllerian duct. (From the collection of Professor R. Meyer, Berlin.)

during the first year of extra-uterine life, and also that the transformation of genital and indifferent cells into primary follicles ceases during the second year (Fischel, 1931). The cells of the theca interna are derived from the stroma of the ovary, and can be seen only in graafian follicles.

In the hilum of the genital gland some of the indifferent cells arrange themselves in the form of cords, *rete cords* (Fig. 285). According to Wilson (1925) these develop at the early stage of 15 mm. and soon extend into the stroma of the mesonephros and come into close relationship with the glomeruli there. In the early stage of development of the rete no differences are noted in the two sexes. In later stages, however, the rete in the male becomes converted into tubules, which fuse with evaginations from the capsules of the glomeruli of the persisting upper portion of the mesonephros to form a portion of the excretory apparatus of the testicle (Fig. 282). In the ovary

The three or four most cranially situated glomeruli and tubules become broken up and lose their connection with the wolffian duct, while those which are preserved maintain this connection. In the male the rete tubules grow into contact and fuse with the evaginations of the glomerular capsules which con-

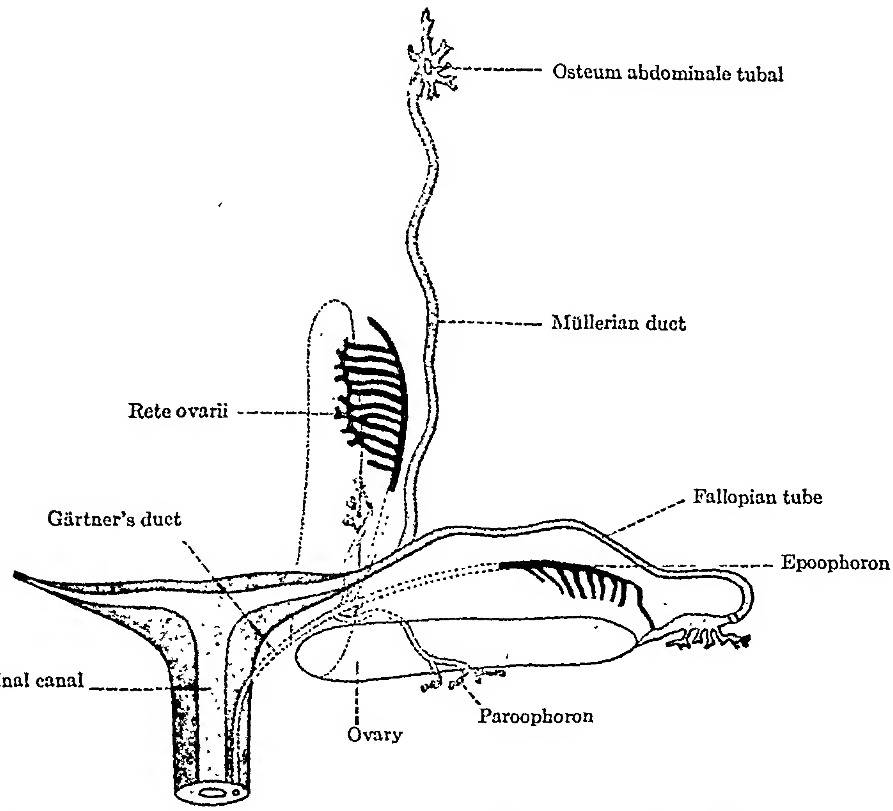

Fig. 287.—A diagram showing the relationship of the ovary to the müllerian duct, and mesonephros. The mesonephros and wolffian duct degenerate. Of the mesonephros the cranial portion persists to form the epoophoron, the caudal to form the paroophoron. Of the wolffian duct only that portion receiving the tubules of the epoophoron is retained, though portions of the rest may persist as Gärtner's duct. (After Fischel.)

nect the former with the wolffian duct (ductus deferens) (Fig. 286). In the female the union is not essential to provide an outlet for the products of the ovary, and the union is imperfect (Fig. 287).

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PRESENTATION[1]

By this term is understood the relation which the long axis of the fetus bears to the long axis of the mother. There are two main divisions of presentation: the longitudinal presentation in which the head or the breech may present and the transverse presentation in which the shoulder is the presenting part. Cephalic presentation is further divided into sincipital presentation, brow presentation, and face presentation. Breech presentation is also divided into frank breech, complete breech, and the various footling presentations.

Causes Which Influence the Occurrence of Presentation.—When we follow the course of normal pregnancy we find, in the early period, roughly the first half, that owing to the small size of the fetus compared with the relatively large uterus, there is no special disposition of the fetal body; it has plenty of room to move about. As pregnancy progresses, however, the rapidly growing fetus gradually fills the uterine sac; the space for movement becomes more limited and the fetus is more or less constrained to dispose itself as a longitudinal mass in conformity with the long axis of the developed uterus. This longitudinal posture of the fetus is found to occur in the second half of pregnancy, more especially toward term in the great majority of cases (about 99.5 per cent). Furthermore, in most instances the head points downward, occupying the lowest segment of the uterus, and so it happens that in about 96 to 97 per cent of all longitudinal postures the head is the presenting part. But even if, through any circumstance, the fetus should be forced into another relationship and lie transversely or obliquely in respect to the long axis of the uterus, reflex muscular contractions of the bulged uterine wall and other factors tend to bring the fetal body back to its longitudinal pose.

While the natural factors leading to a longitudinal posture of the fetus are easily comprehended, it is more difficult to explain the great preponderance of head presentations. Many theories have been advanced in explanation of the problem, but the most widely accepted are those of gravitation and accommodation.

Aristotle believed that the usual head presentation was due to the fact that the head was heavier than the breech and therefore sank to the lowest part of the uterus. In later times experiments by Duncan, Veit, Scanzoni, Seitz and others showed that when a fetus was immersed in a salt solution of approximately the same specific gravity as itself it floated obliquely with the head at the lowest part. Seitz experimented with 40 stillborn fetuses of different ages and found that in the earlier months the relative weights of the breech and head were the same, but that from the eighth month the head became slightly heavier. Nevertheless, he observed that from 70 to 80 per cent of fetuses born before the eighth month were delivered with the head

[1] Since the term "presentation" is used to describe numerous variations in longitudinal presentations such as vertex, brow and face, in cephalic presentations and the several divisions of breech, the term deserves a broader definition. It should be made synonymous with "presenting part." By exact determination of the presenting part we are enabled to decide what relation the long axis of the fetus bears to that of the mother, whether the breech, shoulder or the head presents, and if the head, in what degree of flexion or deflection it lies. The name of each presentation is derived from the presenting part. It is believed that some of the confusion which now exists could be avoided if a change in the definition were made in accordance with these facts.

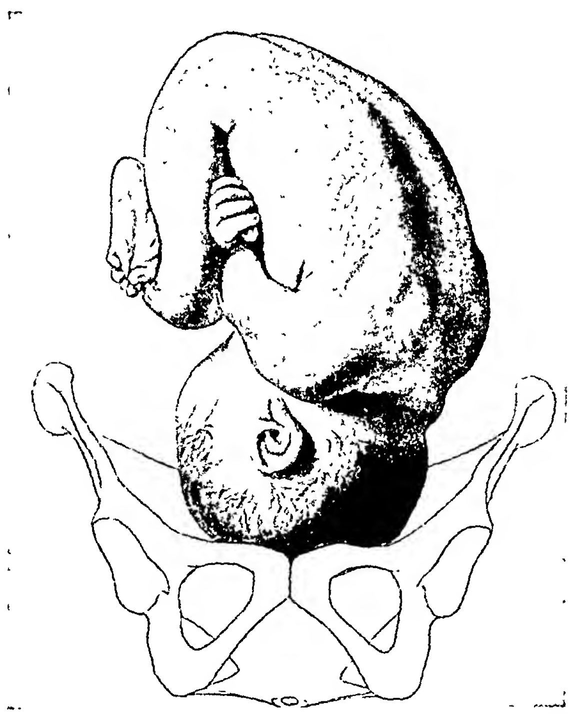

Fig. 288.—Vertex presentation. Occiput left anterior. (Bumm.)

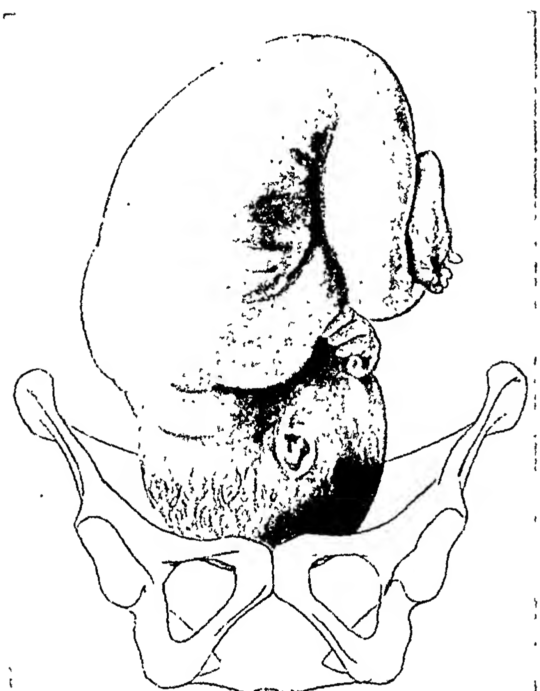

Fig. 289.—Vertex presentation. Occiput right anterior. (Bumm.)

Fig. 292.—Face presentation. Mento left anterior. (Bumm.)

Fig. 293.—Face presentation. Mento right posterior. (Bumm.)

When the child lies across the maternal axis or obliquely thereto, the presenting part is the *shoulder* and the head lies on one side or in one iliac fossa.

The major divisions of presentation and their subdivisions are shown in the following scheme.

(*A*) *Longitudinal presentation:*
  I. Cephalic presentations:
    1. In flexion: vertex or occipital presentation.
    2. In deflection:
      (*a*) Sincipital.
      (*b*) Brow.
      (*c*) Face.
  II. Breech presentations:
    1. Complete breech, both feet and buttocks presenting.
    2. Frank breech, thighs flexed, knees extended.
    3. Footling, single or double.
    4. Knee, single or double.
(*B*) *Transverse or oblique presentation:*
  I. Shoulder presentation.

POSITION

Position in obstetrics has a limited meaning. It is the relation of an arbitrary point on the presenting part of the fetus to the right or left anterior or posterior quadrant of the mother's pelvis. For purposes of description, the cavity of the pelvis viewed from below is divided into four quadrants: right and left anterior, right and left posterior. A designating point which the French call the *point de repere* ("landmark") and in English is called the *point of direction*, is chosen on each presenting part. "The point of direction is that portion of the presenting part which temporarily approaches or ultimately comes to pass under the pubic arch." On the occiput and sinciput the point of direction is the small fontanel; on the breech, the sacrum; on the face, the chin; and in transverse presentation, the scapula. In each presentation, the point of direction will be found in one of the four quadrants of the pelvis or in the transverse diameter. Six positions are thus possible: right anterior, posterior or transverse, and left anterior, posterior or transverse. By accurate identification of the presenting part and the location of the point of direction in one of the four quadrants of the pelvis, the presentation and position are both determined. The parts of the fetus are named according to their relation to the mother in an upright position: right, toward the right side of the mother; upper, toward the mother's head; posterior, toward the mother's back.

The various positions classified by their Latin names and with the abbreviations approved by the International Medical Congress, Washington, D. C., 1887, are shown in the following scheme.

CEPHALIC PRESENTATIONS

1. Vertex—occiput, the point of direction.

Occipito-laeva anterior	O. L. A.
" laeva transversa	O. L. T.
" laeva posterior	O. L. P.
" dextra anterior	O. D. A.
" dextra transversa	O. D. T.
" dextra posterior	O. D. P.

toward the right. In the upright standing posture of the mother, the fetus, in accordance with its weight and its support, will sink anteriorly with the back occupying the roomy left half of the uterus. As the mother is usually twice as long in the standing as in the lying down position the greater tendency will be for the fetal back to be anterior and on the left side. The head tends to follow the position of the back, so that the occiput lies most commonly to the left and in front. Variations in the mechanical factors described result in the other positions. The right posterior is the next in frequency because the fetal back finds more room in the side of the uterus than it does in relation to the anterior or posterior wall.

DIAGNOSIS OF PRESENTATION AND POSITION

Five methods are used in the diagnosis of presentation and position: inspection, abdominal palpation, vaginal or rectal examination, auscultation, and x-ray.

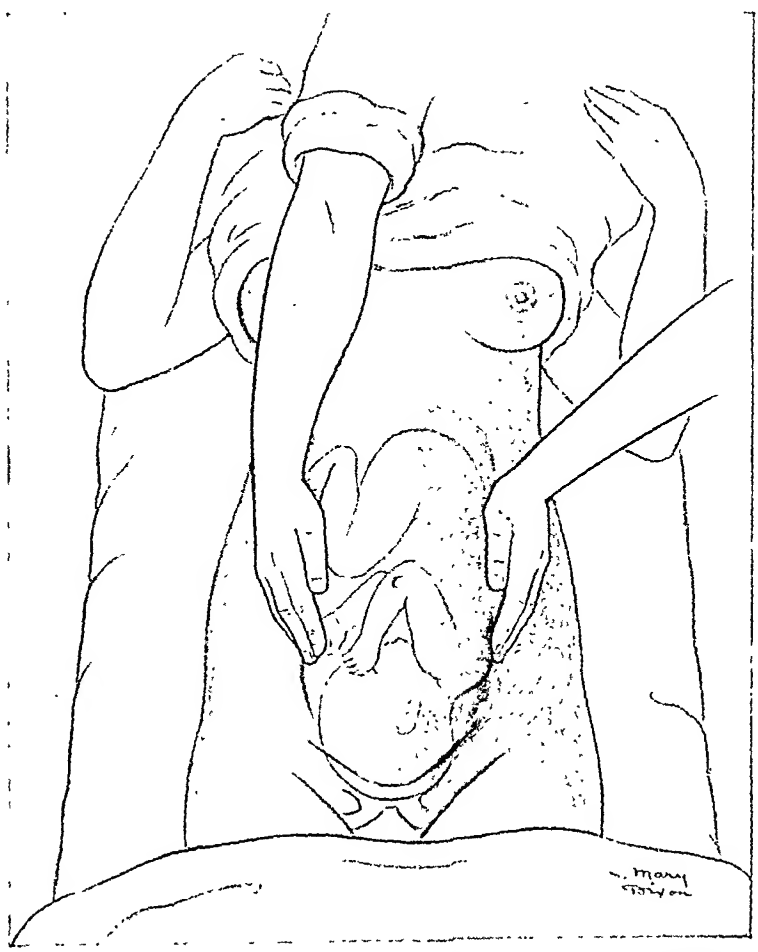

Fig. 296.—Palpating the fetal ovoid. Longitudinal presentation.

Inspection reveals the general shape and size of the abdomen. The normal pregnant uterus at term is symmetrical in shape, somewhat broader above than below, and the longitudinal diameter is greater than the trans-

tion between the bones being very loose, and the fascial covering quite elastic. In vertex presentations the face and forehead are flattened, and the frontal bones and the occipitals are overlapped by the two parietals which in turn overlap, that one which is first subjected to the pressure of the sacral promontory being depressed under the other. As a result of these processes, the head assumes a long, bluntly conical ovoid form, the occipitofrontal diameter much increased, the biparietal and suboccipitobregmatic correspondingly decreased (Figs. 390, 391). This molding is essential to spontaneous delivery

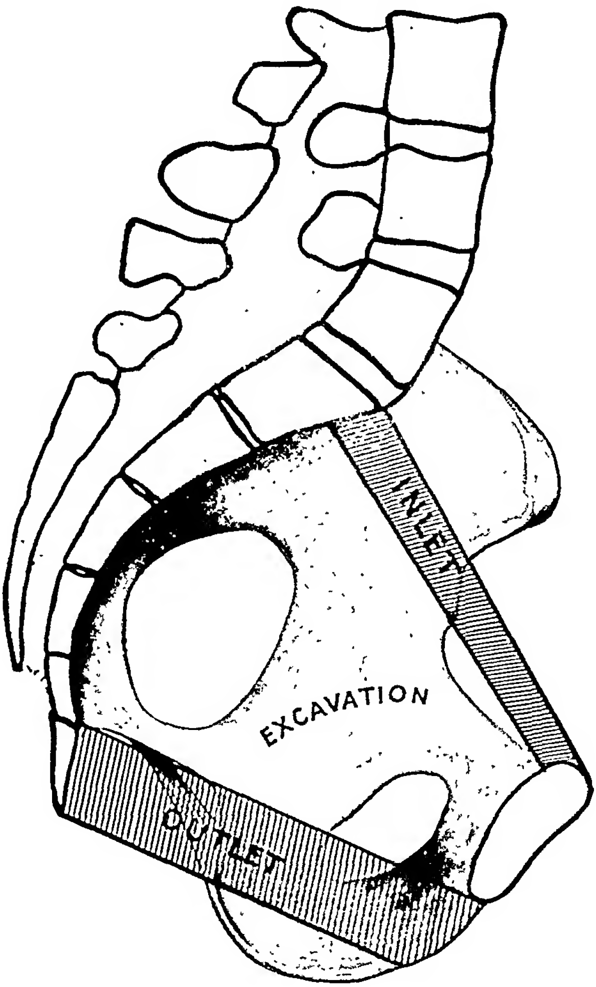

Fig. 388.—The regions of the pelvis. (DeLee, "Principles of Obstetrics.")

in cases where the fetus is of full size and growth and the pelvis normal in contour. When it does not occur, either by reason of postmaturity of the fetus with the attendant advance in cranial ossification, or as a result of pathologic presentation—brow, face, etc.—dystocia generally results. A sequel of molding is the occurrence of numerous minute hemorrhages in the dura and in the periosteum, these bleedings being traumatic, and rarely giving rise to symptoms unless the hemorrhage be excessive.

That portion of the presenting vertex which is in contact with the soft or dilated cervix and is therefore most free from pressure develops a localized,

right ligament lies a little farther away from the midline than the left, because of dextrorotation of the uterus.

The small parts palpated in the fundus are of value in the diagnosis of presentation and position. When found in the lower or middle segments of the uterus they are sometimes misleading. In the fundus they are on the side opposite to the back. The location of the heart tones is only confirmatory

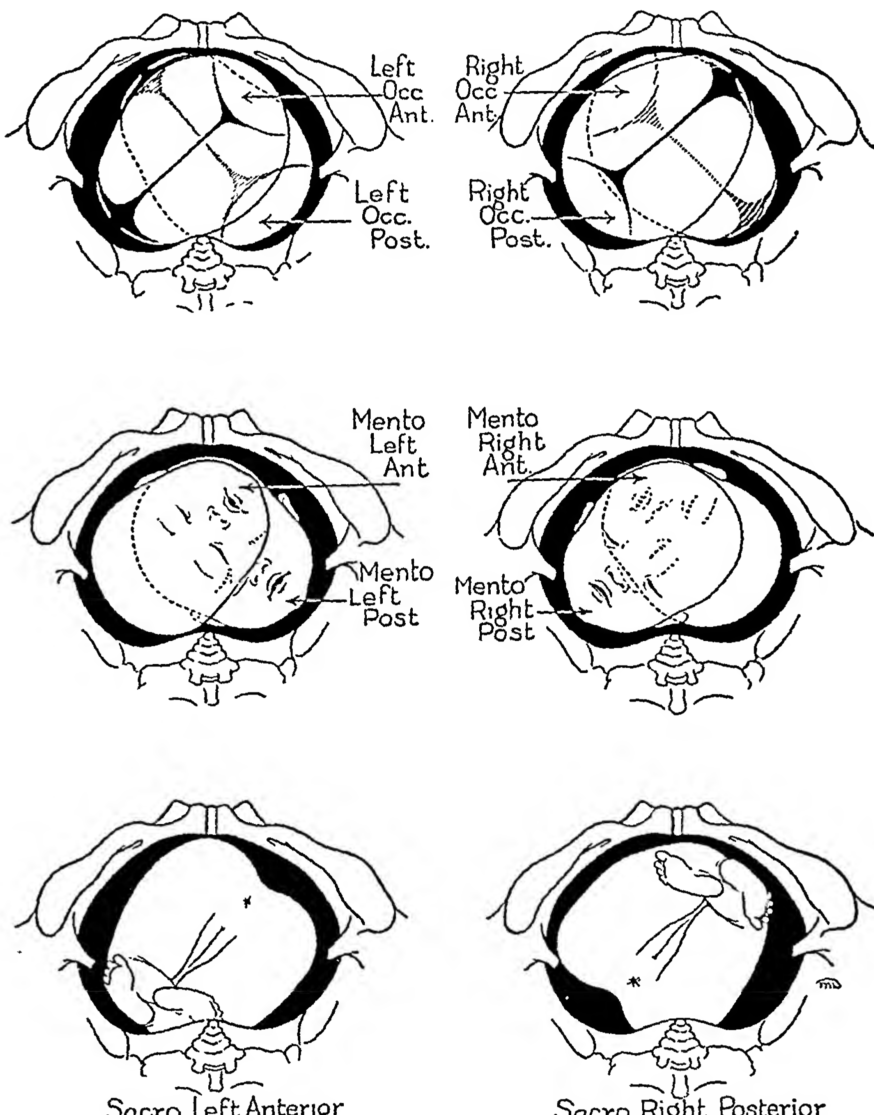

Fig. 301.—Varieties of position.

evidence of presentation. In vertex cases they are heard best in the lower quadrant of the abdomen on the right or left side. When the back is posterior, the point of greatest intensity may be well around in the flank. When the breech is down, the heart tones are on a level with or above the umbilicus on the side where the back lies. In face presentation, the chest of the baby may lie close to the abdominal wall of the mother and the heart tones are heard loudest over this area, in one of the lower quadrants.

occiput is anterior; in occipitoposterior positions, it is found four or five fingerbreadths away from the midline, toward the flank.

Auscultation of the fetal heart tones is of value in determining the location of the back. The point of greatest intensity is on the side where the back or the shoulder of the baby comes in contact with the uterine wall. The tones are transmitted better through a solid medium than through a fluid. If the back is deflexed the heart beat may be heard with equal or greater intensity on the opposite side. In breech presentation it is heard best above the level of the umbilicus; in cephalic presentations, on one side or the other, in one of the lower quadrants of the abdomen.

The abdominal findings may be so obscured by the presence of hydramnion or by thick tense abdominal walls that an accurate diagnosis by external examination is impossible. In multiple pregnancy the diagnosis of the presentation and position is often difficult. Under such circumstances examination by means of the x-ray may be the only method by which the presentation can be determined.

Diagnosis of Presentation and Position by Vaginal Examination.—The diagnosis of the presentation by internal examination requires first the identification of the presenting part. Vertex presentations present a smooth, hard, round surface. The large and the small fontanels, connected by the sagittal suture, are the prominent landmarks on the vertex. Three sutures unite in the form of a Y to form the small fontanel. The upright portion of the Y is formed by the sagittal suture. The large fontanel, at the opposite end of the sagittal suture, lies at the junction of four sutures. The number of sutures which enter a fontanel serve best for its identification. In occipital presentation the small fontanel is found in one of the four quadrants, somewhat nearer the periphery than the center of the pelvis. The large fontanel lies at a higher level; if flexion has been maintained or the cervix is not completely dilated this point cannot be reached by the examining finger. The location of the small fontanel in one of the quadrants determines the presentation and position, which may be occipito-right-anterior or posterior, or occipito-left-anterior or posterior.

Sincipital presentation is recognized by finding the large and small fontanels at about the same level, with the sagittal suture extending from one to the other. In this presentation the small fontanel is the point of direction and the position is named for the quadrant of the pelvis in which it lies.

In brow presentations the large fontanel is found on one side of the pelvis and the supra-orbital ridges on the other. The brow lies between the two and is the point of direction. The position is fronto-right or left anterior or posterior, named for the quadrant of the pelvis in which the forehead lies.

If the presenting part is soft and irregular, it may be either the breech, the shoulder or the face. The face is soft, owing to congestion and swelling of the cheeks and lips. The breech is identified by the sacrum and the ischial tuberosities with the anus between. The anus may be differentiated from the mouth by the absence of the alveolar processes. Sometimes the scrotum of a male infant may be palpated. The position is named from the quadrant of the pelvis in which the sacrum is located: sacro-right or left, anterior or posterior.

The shoulder is recognized by the axilla, the costal gridiron and the scapula. The closed apex of the axilla points toward the side on which the

CHAPTER XIX

MATERNAL CHANGES INCIDENT TO PREGNANCY

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In recent years, the subject of the mutual reactions of pregnancy and the organic diseases associated with and incident to gestation has received wide attention. It was in the study of these interrelations that investigators soon realized that for a sound understanding of abnormalities it is first necessary to comprehend and control the norms. In consequence, we are coming more and more to recognize the necessity of a proper knowledge of the normal structure and normal function as a preliminary to the elucidation of pathologic lesions and deflected functions. "To become good and enlightened practitioners, we must become able physiologists" (Marshall Hall).

Thus, as knowledge advanced it became evident that pregnancy affects the entire organism, creating radical changes not only in the reproductive organs but in other systems as well. While, in the past, such alterations of organic structure and function were attributed largely to nervous impulses, originating in the pregnant uterus, recent investigations tend to correlate them with hyperactivity and hyperfunction of certain ductless glands (anterior pituitary, thyroid, the adrenal cortex, the chorionic epithelium).

URINARY TRACT

Our knowledge concerning the nature and the pathogenesis of parenchymatous changes of the *kidney* in pregnant women is far from complete; this deficiency is reflected in the diversity of opinions regarding the condition. Much of the literature on the subject is unintelligible, since it fails to specify the particular type of renal involvement. There is a consensus of opinion, however, that the kidneys are not severely or permanently damaged, as evidenced by their prompt return to normal after delivery. Cloudy swelling of the epithelium of the convoluted tubules, swelling of the capillaries of the glomeruli and hyalinization of the afferent arterioles have been described as the essential features of a condition which has no analogue in pathology and which, for want of a more fitting term, is called "the kidney of pregnancy." Coincident with these changes there occurs in the normal pregnant woman, beginning with the fourth month of gestation, an increased permeability of the kidneys with regard to the excretion of sugar, as evidenced in the positive alimentary glycosuria test, with persistent normal blood sugar readings. A minute amount of albumin along with a small number of hyaline casts is detectable in the urine of a large percentage of normal pregnant women during the last few weeks of gestation. This slight albuminuria, unassociated with deviation from the normal in other routine functional tests, is a characteristic of pregnancy. The factor responsible for the status of the kidneys

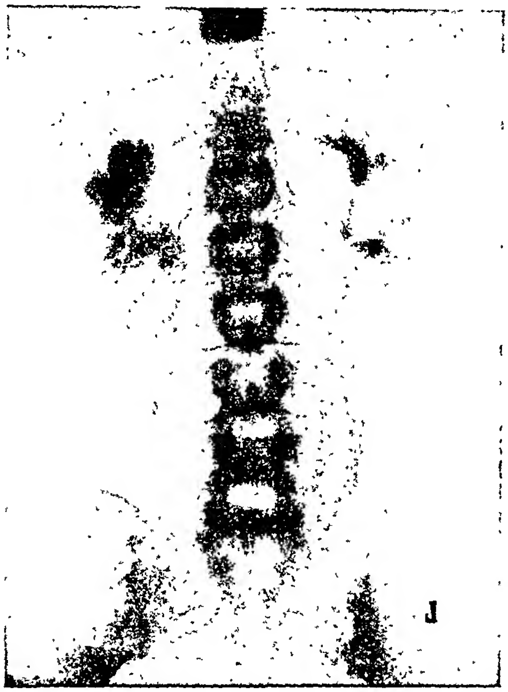

Fig. 303.—Primigravida mens. VIII. Fetus in L. O. A. Note dilatation of right ureter and renal pelvis. Marked outward dislocation of right ureter. Urine normal.

Fig. 304.—Primigravida mens. IX. Fetus in R. O. A. Course of pregnancy asymptomatic. Urine clear. Bilateral ureteral and pelvic dilatation.

shows a moderate thickening, due both to edema and the advent of young connective tissue fibers. Now and then, there is an accumulation of lymphoid

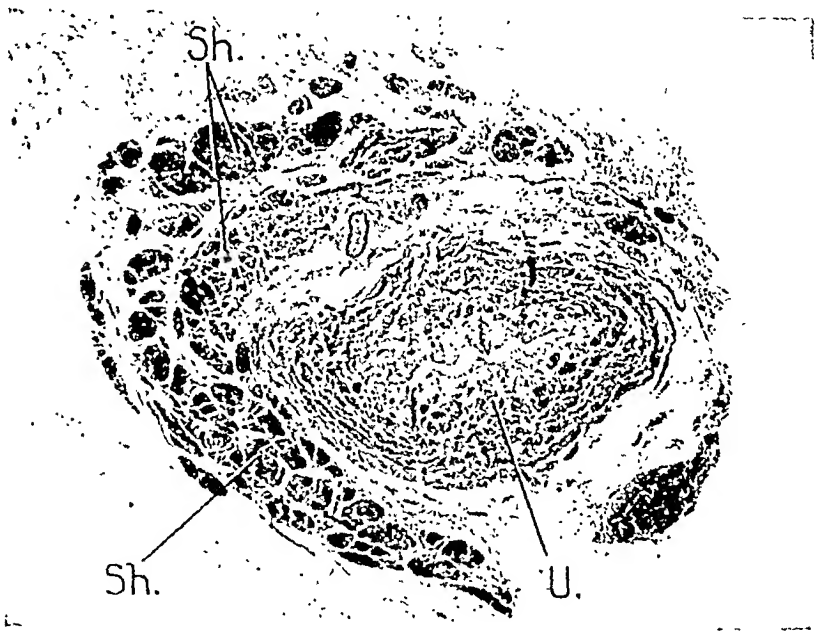

Fig. 306.—Pregnant ureter at term, juxtavesical portion 2 mm. above ureterovesical junction. *Sh.*, ureteral sheath: *U.*, ureter.

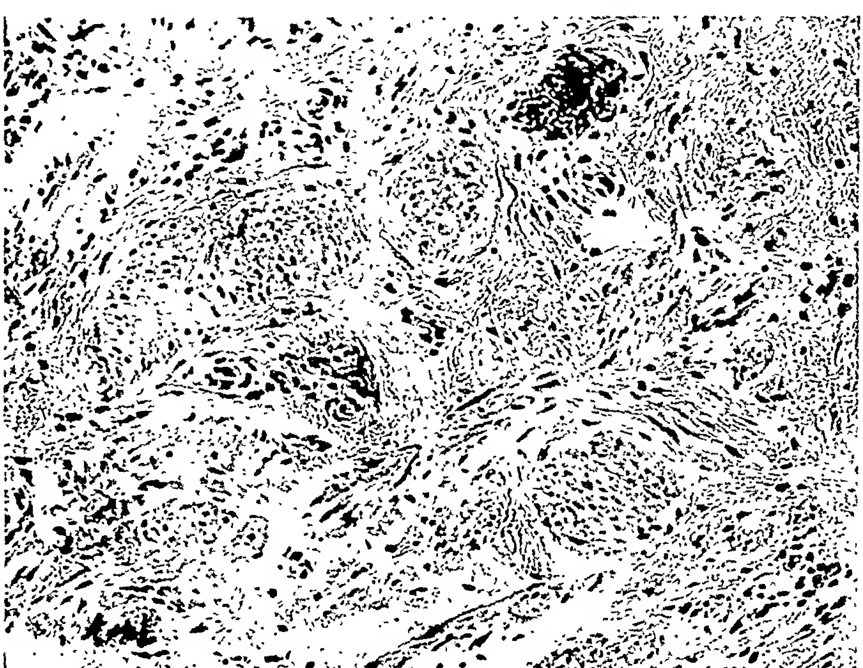

Fig. 307.—Photomicrograph of juxtavesical portion of pregnant ureter. Note abundance of fibroblasts between muscle bundles.

tissue. The epithelium is arranged in several layers, the individual cellular element having nearly doubled in volume. Lymphocytes, plasma cells and

In striking contrast with the regular occurrence of rearrangement in the lower ureter, noted in our specimens, the findings in the upper part lack uniformity. The increase in size in the muscular bundles, although occasionally definite, appears by no means constant. On the other hand, the intercalation of various numbers of fibroblasts both within the mucosa and within the muscular coat extends throughout the entire course of the ureter. The whole complex of connective tissue in the upper urinary tract is loose and delicate, an undulating course of loosely arranged connective tissue fibers predominating, in contradistinction to the density of structure seen in the lower urinary tract. Reference to Fig. 309, a photomicrograph of the ureter 9 cm. above the ureterovesical junction makes these features clear.

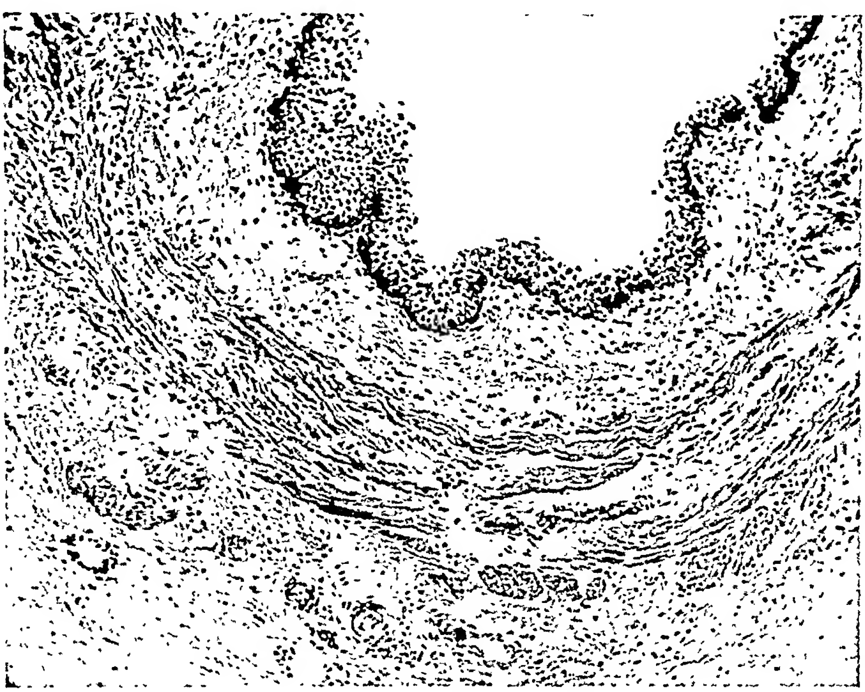

Fig. 309.—Photomicrograph of pregnant ureter 9 cm. above ureterovesical junction (× 84).

Before entering into the second phase of our subject, which is concerned with ureteral atony in pregnant women, the reader's attention is directed to the clinical evidence at hand, viz., that protracted ureteral distention is commonly attended by an insufficiency of ureteral peristalsis. At the same time, the occurrence of atony coincident with slight ureteral dilatation in the early months of pregnancy calls for another etiologic factor. In this connection, brief reference should be made to recent experimental work, demonstrating the depressing effect of substances lowering the surface tension of the blood, upon both the tonus and the contractions of the ureter; the phenomenon being due to the increase of cholesterol and bile acids in the blood during pregnancy.

The first indication of ureteral dilatation occurs about the tenth week of pregnancy. By using intravenous pyelography, which enables us to study the efficiency of the kidney in regard to the time and the rate of excretion of uroselectan, it became evident that the dilatation of the pelvis, by reason of

istic feature. Vigorous peristalsis, extending from the cardia down to the pylorus, with associated circular contractions in the pyloric region, are recognizable during the first four months of pregnancy in about 60 per cent of cases examined. Such phenomena occur less distinctly during the ensuing months. In exceptional cases, antiperistalsis of the stomach is noticeable on the screen. The bearing of such findings on the causation of vomiting in pregnancy is obvious.

A loosening and a slight edematous imbibition of the mucosa of both the small intestine and the appendix have been described. The practical aspect of the matter is that such observations may afford a plausible interpretation for the occurrence, in some instances, of an increased penetrability of the intestinal wall to split products of digestion and to bacteria. The occurrence of asymptomatic bacteriuria in a large percentage of apparently normal pregnant women has been reported by some writers as probably due to an increased resorption of intestinal bacteria. Abnormal conditions for absorption of digestive products (histamine) may be regarded as possible etiologic factors in certain types of toxemia of pregnancy. The significance of these important observations will not be apparent until the much disputed possible increase in permeability of the intestinal wall during pregnancy has been definitely settled.

Upward displacement of the cecum and the appendix, as a result of growth and expansion of the pregnant uterus, was first described by Füth. Routine *x*-ray examinations of pregnant women by other investigators have failed to establish the regular occurrence of this phenomenon. Quite recently, however, definite appendiceal displacement in pregnant women was demonstrated by the roentgenological investigations of Baer and of Schumacher. It was found that the appendix undergoes progressive displacement upward after the third month, reaching the level of the iliac crest at the end of the sixth month. After the seventh month of pregnancy, the case of the appendix appears to be lying above the iliac crest in approximately 90 per cent. In exceptional cases, the upward displacement of the appendix by the growing uterus may shift the organ far above McBurney's point, occasionally even under the costal arch. The colon, also, is pushed upward and curves around the uterine fundus, the cecum being crowded upward and outward.

The bearing of these phenomena on the seriousness of appendicitis in pregnant women needs no emphasis.

RESPIRATORY SYSTEM

In comparatively recent times, much has been learned concerning changes in the laryngeal mucosa occurring during pregnancy. Accurate information was obtained both by careful study of the histology and by direct inspection of the interior of the larynx. The microscopical appearance of the laryngeal mucosa during gestation may be summarized as follows: Hyperemia, edema, cellular infiltration (with aggregations of lymphocytes, plasma cells and decidua-like elements). Laryngoscopy in pregnant women reveals striking changes in the interarytenoid region and in the false cords, where marked hyperemia and edematous imbibition bear some resemblance to inflammatory processes. In a certain percentage of cases, the interarytenoid region may show an excessive development of edema, resulting in the formation of a plateau-like structure which protrudes into the laryngeal cavity. Under

in resistance to infection which the pregnant organism possesses. The elucidation of certain clinical phenomena in pregnant women which has resulted from such studies is obvious.

There is an increase in the sedimentation rate of the red blood corpuscles during the second half of pregnancy. This is very probably due to an increase of both the globulin content and the viscosity of the plasma. Another interesting physico-chemical phenomenon is lowering of the surface tension of the blood serum in pregnancy which is noticeable from the third month and which becomes more pronounced as pregnancy advances. The relation of this phenomenon to the etiology of ureteral and uterine atony during pregnancy was discussed recently. Normal gestation is associated with an increase in neutral fat (lipemia) as well as cholesterol. Estimation of the lipolytic index during the successive months of gestation shows a gradual decline. There is a slight progressive decrease of the calcium content of the serum during the second half of gestation. During the first six months of pregnancy the concentration of proteins in the plasma falls from the normal average of 7 per cent to about 6.2 per cent, rising again during the latter months almost, but not quite, to the normal level. The carbon dioxide combining power of the plasma is likewise decreased and, at term, is approximately 45 per cent, as compared with about 65 per cent in nonpregnant women. A decrease in alkali reserve in the blood as well as a reduction in total base, during the second half of pregnancy, are outstanding features. Alveolar carbon dioxide tension decreases in pregnancy (Hasselbach). Readings of the hydrogen-ion concentration show that the reaction of the blood remains normal until the seventh month, when it begins to move slightly toward an alkalosis which persists until the time of parturition. A marked increase in fibrinogen is an invariable phenomenon of normal pregnancy.

Much interest has centered, of late, in the subject of *physiologic anemia of pregnancy*. It was found that a deficiency in the number of red blood cells and in the hemoglobin content is not an unusual occurrence, hemoglobin readings below 70 per cent occurring in 60 per cent of normal pregnant women during the first two trimesters, while at term, in many cases, the figures show a slight rise (Esch, P. Brooke Bland and Goldstein). Furthermore, marked improvement was noted in most instances after delivery. Among the factors which were elaborately discussed with regard to this type of anemia, the occurrence of hemolytic processes due to the presence of a syncytial hemolysin in the epithelial covering of the chorionic villi deserves particular attention. Destruction of maternal blood cells at the surface of the villi, most pronounced in the first half of pregnancy, has been clearly demonstrated in the past. It is obvious that such phenomena concern chiefly the requisition of the proper amount of iron for the fetal organism, and this mainly in its erythrocytes and its liver. Bone marrow hypoplasia was also discussed as an etiologic factor in certain types of anemias of pregnancy which become most severe between the sixth and eighth months and are progressive from one pregnancy to another (Whitby).

In the later months of pregnancy the bone marrow apparently becomes hyperactive. The reticulated erythrocytes increase, yet fail to bring the blood count back to normal. As a constant concomitant of pregnancy, there occurs a slight rise of the leukocyte count at term, which becomes distinctly accentuated under the stress of labor.

many a question with finality. At the same time it is true that numerous new facts have accumulated which may provide a key to the proper explanation of certain hitherto obscure phenomena.

Indeed, such problems have been rendered more complex by evidence, abundantly demonstrated in recent years, and pointing to an intimate relationship between the activity of the ductless glands, the vegetative nervous system and the electrolytes. The products of the ductless glands exert a definite influence upon the vegetative system, while the latter ultimately controls the action of the hormones. The distribution in the cells of the electrolytes, while essentially controlled by both the hormones and the vegetative nervous system, determines, in its turn, the effect of the hormones. Another phase of the subject in question concerns the interdependence of the various ductless glands. They apparently represent one connected chain; and any change in the equilibrium, by reason of altered conditions in one link, tends to evoke an immediate response by way of synergism or antagonism, on the part of the others.

Pituitary.—Change in the hypophysis during pregnancy is characterized by a remarkable hypertrophy of the anterior lobe. This increase in size is more distinct in multiparae than in primiparae. In some cases the weight of the gland may nearly double. Occasionally, as the result of an excessive enlargement of the pituitary there is compression of the optic chiasm, manifesting itself by bitemporal contraction of the visual fields, which varies in degree according to the amount of hypertrophy and compression (Alpers). Recession of the hemianopsia takes place about the tenth day postpartum, with a subsequent return to normal. Histologically, the enlargement of the anterior pituitary is seen to be due to overgrowth of the chromophobe or chief cells, which dominate the eosinophilic and basophilic elements and now appear transformed into large ovoid cells with clear eccentrically located nuclei (pregnancy cells). Their abundant cytoplasm is filled with fine, dust-like granules, staining pink with eosin. Transitions may be seen between these elements and the eosinophilic cells. The new structure often appears to be arranged in definite adenomatous masses or in columns adjacent to the capillary sinuses, outnumbering the normally dominant eosinophilic elements. The latter, together with the basophiles, are displaced toward the centers of the adenomatous islands. These islands show a distinct increase in size as compared with the acini in nonpregnant specimens. Within seven weeks after labor the "pregnancy cells" (modified chromophobes) return to their original status, although their number may remain larger than before. Diffuse hyperplasia of the anterior lobe arising from functional overgrowth occurs in most advanced form after multiple pregnancy. Transitions to atypical adenomata of malignant type have, however, been observed (H. Boyd).

Since Berblinger and others were able to initiate typical gestational changes in the anterior hypophyseal lobe of laboratory animals by the injection of placental extracts, it seems plausible to infer that the trophoblast of the chorionic tissue may serve as the normal stimulus to the pituitary during pregnancy. In consequence of hypertrophy of the anterior pituitary in pregnant women, its association with various phenomena incident to pregnancy has become a fertile field for investigators. Recent evidence of systemic changes, following the implantation of anterior pituitary substance or

associated with a sharp drop in the carbon dioxide combining power of the blood (Draper), a definite lowering of the oxygen consumption of the tissues and a marked increase in the lactic acid content of the blood (Himwich, Geiling). It is common knowledge that these are characteristic biochemical happenings in eclampsia.

Thyroid.—During the course of gestation, this organ manifests a deflection from the normal by changes, both anatomical and functional, which may be interpreted as evidence of increased activity to meet the added demands of pregnancy. Histologic evidence suggests a true hyperplasia of the adenomatous tissue while, in discreet places, colloid is stored in excess of the normal. The epithelium lining the acini proliferates and becomes columnar, active cell division occurring here and there. The proliferating epithelium is seen to project into the enlarged acinar spaces in the form of processes which accommodate the increased number of cellular elements. The noticeable enlargement of the thyroid in pregnant women is due to these proliferative processes, to a new formation of follicles and to an increased vascularity of the organ (Falls, Mussey, and Plummer). With the termination of pregnancy, the thyroid dwindles to normal size, decreased vascularity and true involution of the parenchyma being the main features of this retrograde process.

Of late years, several interesting facts have been elicited, indicating functional changes accompanying the hyperplastic processes of the thyroid during pregnancy. An increased iodine content in the blood of pregnant women has been established by the researches of Scheringer. Evidence of a distinct increase of the thyroid hormone came from the experimental fact that development in tadpoles may be accelerated by the addition of blood obtained from pregnant women to the surrounding medium (Eufinger). We may further assume thyroid hyperactivity from the rapid diminution of the glycogen content of the liver and from increase of ketone bodies in the urine and blood during pregnancy (Anselmino and Hoffmann, Eufinger and Wiesbader).

Certain clinical features of pregnancy also suggest augmented activity of the thyroid hormone, as evidenced by increase in the rate of metabolism (20–30 per cent above the normal; especially pronounced during the latter stages of pregnancy), and increased irritability of the peripheral nerves as shown by a response to an electric current of 0.9 ma. as against 1.8 ma. in the nonpregnant state (Seitz). Symptoms suggestive of mild hyperthyroidism (nervousness, insomnia, tachycardia, increased nervous instability, mild degrees of disturbance of mental equilibrium), are known to occur in a certain number of pregnant women (Falls).

An added strain on the *parathyroid* bodies during gestation appears probable from the fact that the removal of portions of these structures is negative in experimental animals, while symptoms of tetany appear whenever such animals became pregnant (Frommer, Thaler). These observations accord with the clinical fact that in certain patients tetany occurs during pregnancy only, and is otherwise absent.

Adrenals.—The structural changes in the adrenals incident to pregnancy have been minutely described by Stoerk and Haberer. The entire cortex becomes hypertrophied, numerous mitotic figures and vacuoles appearing in the zona fascicularis. Abundance of lipoids is conspicuous in the adrenal

refer to the most recent studies pointing to a satisfactory solution of the problem.

Schmidt and his associates determined by exact methods the glycogen content of the liver in pregnant dogs and found only 57 per cent of the normal estimate. These investigators also showed that the capacity of the liver cell for storing glycogen is decidedly lowered during gestation. Extensive data on modern functional liver tests during the successive months of gestation have been reported by C. Kaufmann. It is important to consider these at some length. First, by employing von Bergman's sensitive bilirubin test (excretion of 50 mg. of injected bilirubin from the blood stream within four hours, when the liver function is normal) a very definite delay in the time of excretion was noted from the fifth month on, in about 50 per cent of the cases examined. Secondly, beginning with the fourth month, the capacity for the assimilation of levulose was obviously impaired in the vast majority of pregnant women. Finally, when an attempt was made to determine the glycogen content of the liver by the method of Bürger, who had established an initial hyperglycemia following the intravenous administration of insulin in normal cases, hyperglycemia was noted in only 40 per cent of pregnant women examined during the second half of gestation. Furthermore, disturbance in carbohydrate metabolism is plainly indicated by the advent of creatinuria (Riesser) during the last few months of pregnancy. The results obtained in pregnancy by Kaufmann with Bergman's liver test have been corroborated by still unpublished studies conducted in our department, showing in nearly every instance a definite delay in the excretion of the dye during the second half of pregnancy. This test may now be regarded as an ideal index of derangement of hepatic function.

In the light of these results, we may take it as proved that a definite, if slight impairment of liver function (insuffisance hépatique), with glycogen deficiency as its outstanding feature, is constant in a large percentage of normal pregnant women, particularly in the second half of pregnancy.

GENERATIVE TRACT

Parametrium.—The literature on the reinforcement of the natural defenses of the body against infection, through well-defined cellular activities, is vast. Turning to the status of the parametrium during pregnancy and labor, we find that the mechanisms for repelling invasion of bacteria during labor are clearly demonstrable in the tissues involved. To understand the biological response of the parametrium to the stress of bacterial attack, familiarity with the nature and the significance of certain parametric processes associated with pregnancy is essential.

Until recently little attention has been given to histologic features, in particular the mechanism by which the parametrium is enabled to resist infection. This defect in our knowledge has been filled in part by recent investigations. It has been shown that, while the base of the broad ligament in nonpregnant women is built up of dense fibrillar connective tissue with but few cell elements and occasional bundles of plain muscle, throngs of well-characterized cells make their appearance in this region at term and during labor. These cells are arranged in relation to the course of the uterine lymphatics and fall readily into two types. One group consists of cells to which the name "clasmatocyte" or "histiocyte" has been applied; while the other

From the third month of pregnancy on, there is an evident increase in number of the original cells within the parametrial tissue. In part, they still lie in close proximity to the small vessels in groups of two to four; in part, however, they are distributed between the tissue fibers. But there is a noticeable difference in their relative number in the various places. Transitional forms appear, on closer study, and in some instances the first phenomenon observed is that the cytoplasm grows more voluminous, while at the same time the outlines of the cells become ragged or irregular as the result of the formation of protruding processes. Here and there vacuoles make their appearance. The microphotograph (Fig. 310) shows these conditions. With the advance of pregnancy a perceptible increase of the original cells in the parametrium is noticed. Lying in groups of five or six, they present all the transitional stages leading to the formation of monocytes and clasmatocytes. Mitotic figures are decidedly more frequent than in the earlier months. It is noteworthy that the specific spindle-shaped connective tissue cells appear broader and longer through swelling and that this transformation throws the whole structure into relief. As these elements hypertrophy they acquire some phagocytic power, as evidenced by their ability to store blood pigment.

At term, a dense collection of macrophages can be seen within the parametrium, both monocytes and clasmatocytes being quite conspicuous. Furthermore, cells of another type appear in the immediate neighborhood of the smaller blood vessels. These are characterized by the accumulation in their cytoplasm of coarse granules, which take up eosin with avidity. Striking transitional stages can be demonstrated all the way from the original cell to the elements just described and from the latter to the monocytes and the clasmatocytes. It would appear that this type of cell, originally limited to the immediate vicinity of blood vessels, may be regarded as the stem cell which furnishes the recruits for the army of macrophages in the parametrium.

The remarkable development of phagocytic tissue within the tissue spaces of the base of the broad ligament is particularly accentuated under the stress of prolonged labor, with superadded intra-uterine infection—a period which represents the high-water mark of macrophage activity. Monocytes and clasmatocytes occur in rows, arranged in relation to the course of the lymph spaces. They exhibit phagocytic activity, as shown by the intracellular inclusion of blood pigment or fragments of erythrocytes. The clasmatocytes present great variation in shape and dimension. Their conspicuous cytoplasm presents a vacuolated appearance. The accompanying figure illustrates the neoformation of phagocytic tissue within the parametrial tissue at term, with a beginning infection reinforcing the biological response.

All this suggests the recent views of immunologists, concerning increased local resistance whereby the organism defensively responds. The forces of natural resistance are biological reactions of the physiologic emergency apparatus, called into play when bacteria or foreign materials enter the tissues. The basic significance of the implication of mononuclear cells in the various processes of resistance and immunity has been emphasized in recent years by Gay, Morrison, Besredka, *et al.* Clinical evidence seems to warrant the inference of these investigators that there is a remarkable increase in local resistance to streptococcus infection when sufficient monocytes and clasmatocytes are present. "Once mobilized, there is no difficulty in demonstrating

During the last few months of pregnancy, a marked distention of the veins in the uppermost portion of the broad ligaments is noticeable in a certain number of cases. Failure of their involution may result in the persistence of a pampiniform plexus of varicose veins (*varicocele*) in the mesosalpinx.

The **pregnant uterus** undergoes a vast increase in size. At term, it is about 32 cm. long and weighs about 1000 Gm., this enlargement being mainly due to hypertrophy of the preexisting muscle cells. The fully developed muscle fibers are from two to seven times wider and from seven to eleven times longer than those observable in the nonpregnant organ. Formation of new muscle fibers in the wall of the pregnant uterus has been described by Koelliker, Stieve, *et al.* My researches, however, indicate that mitotic figures occur in the outermost layer only.

Fig. 312.—Parametrial tissue at term, showing hypertrophy of the sheaths of the uterine vessels and newly formed strands of unstriated muscular fibers extending into the broad ligament.

Figure 313 exemplifies the architectonic structure of the wall of the pregnant uterus under low magnification. Beneath the peritoneal covering we find a thin superficial layer of relatively compact longitudinal fibers, above a thicker layer of circular fibers, spread apart by characteristically arranged connective tissue spaces, containing many vessels. Internal to this, again, comes a layer of muscles interlacing in both directions, and further within comes the bulk of the uterine muscle, a dense feltlike mass of fibers extending to the base of the decidua. Hence, it is possible to divide the muscular wall of the pregnant uterus into two parts, a thinner exterior and a thicker interior portion.

the organ increases more rapidly in length than in width, and assumes an oval form, which persists until the end of pregnancy. By the fourth month the organ becomes too large to be contained in the pelvic cavity, and forms a tumor, the upper border of which reaches 3 cm. above the symphysis. As this becomes still larger, it reaches the umbilicus and later on comes in contact with the anterior abdominal wall, displacing the intestines to the sides of the abdomen, and gradually extends upward until it almost impinges upon the costal margin. During the first few months of pregnancy the uterine walls are considerably thicker than in the nonpregnant condition, but as gestation advances they gradually become thinner, so that at the end of the fifth month they are from 3 to 5 mm. in thickness, this measurement being retained throughout the succeeding months.

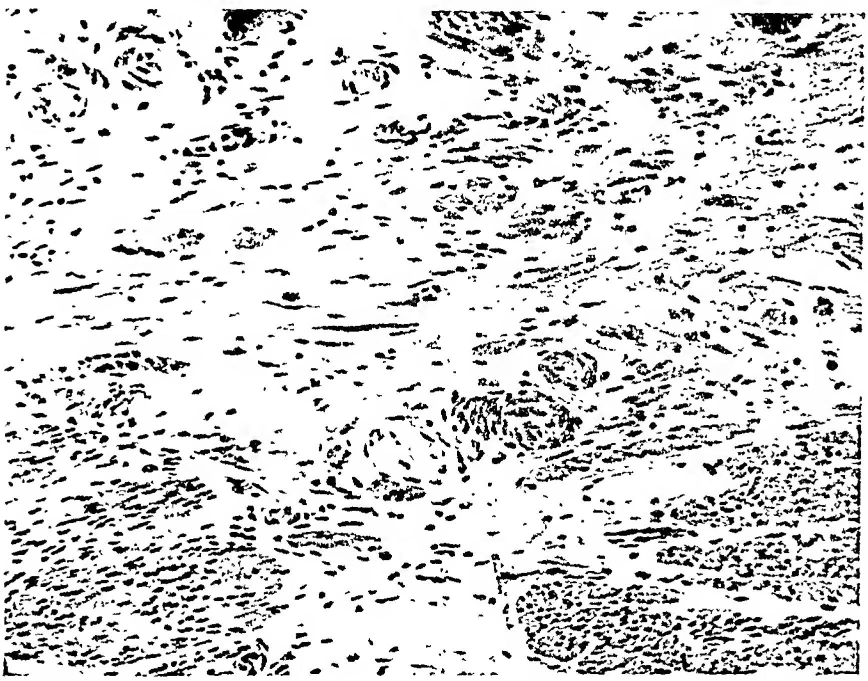

Fig. 314.—Photomicrograph of lower uterine segment in the sixth month of pregnancy, showing development of numerous fibroblasts. Note broad connective tissue spaces between muscle bundles.

The structure and function of the outermost layer of the pregnant uterus have challenged the attention of several investigators in the past. Hélie, Henle, and Bayer have noted remarkable rearrangement of this layer, which, during pregnancy, forms an external hoodlike structure, arching over the fundus and extending into the various ligaments. Certain newer microscopical features of the outer muscular stratum were described by the writer (in 1929), who stressed the development in this layer of a specialized structure, the microscopical peculiarities of which are in marked contrast to the rest of the uterine muscle and closely resemble the conductive system of the heart. The structure in point is conspicuously differentiated by the clear diaphanous character of its specific elements and, also, by the well-developed connective tissue sheaths which surround the individual bundles and separate them into several divisions. Figure 315 illustrates the characteristic features of the

2 to 3 inches wide, composed of parallel fibers, is visible over the anterior surface all the way from the bladder reflection to the fundus, resembling in its pattern the tenia of the large intestine. The wave of contraction spreads from this band and involves an ever-increasing area of the pregnant organ. Synchronous with the first appearance of the tenia in the midline there comes into view an orbicular structure surrounding the insertion of the tubes, as well as a pale zone in the midline of the posterior aspect of the lower uterine segment. These phenomena are most striking when the operation is performed under spinal anesthesia.

Viewed in this way, the specialized system reveals itself as a particularly susceptible structure, through which the uterine impulses are probably

Fig. 316.—Cervical mucosa; middle of pregnancy. Note area of proliferation and metaplasia of surface epithelium (× 90).

propagated, the system acting in some way as the pacemaker for uterine contractions. This conception is reinforced by the recent experiments of Ivy and associates. Inquiry into the factors which may determine the coördination of uterine activity during labor led these workers to assume that the structure in question possibly is an analogue of the His' bundle in the heart.

Shortly after the fertilization of the ovum, the *mucous membrane of the uterine body* becomes converted into the decidua which attains a thickness of from 5 to 10 mm. It consists of a thin superficial compact layer and a spongy layer of considerable height. The characteristic elements of the decidua are closely packed, large oval or polygonal cells of epithelioid character—derivatives of the stroma cells of the endometrium.

outgrowths quite often extend into and interlace with the connective tissue fibers of the broad ligament.

Peritoneum.—The recognition of the appearance of ectopic decidua on the peritoneal surface of the pregnant uterus dates back to Schmorl who, in 1898, emphasized the fact that in the pregnant organism decidual formation is not confined to the endometrium, but may also occur at other sites. Of these,

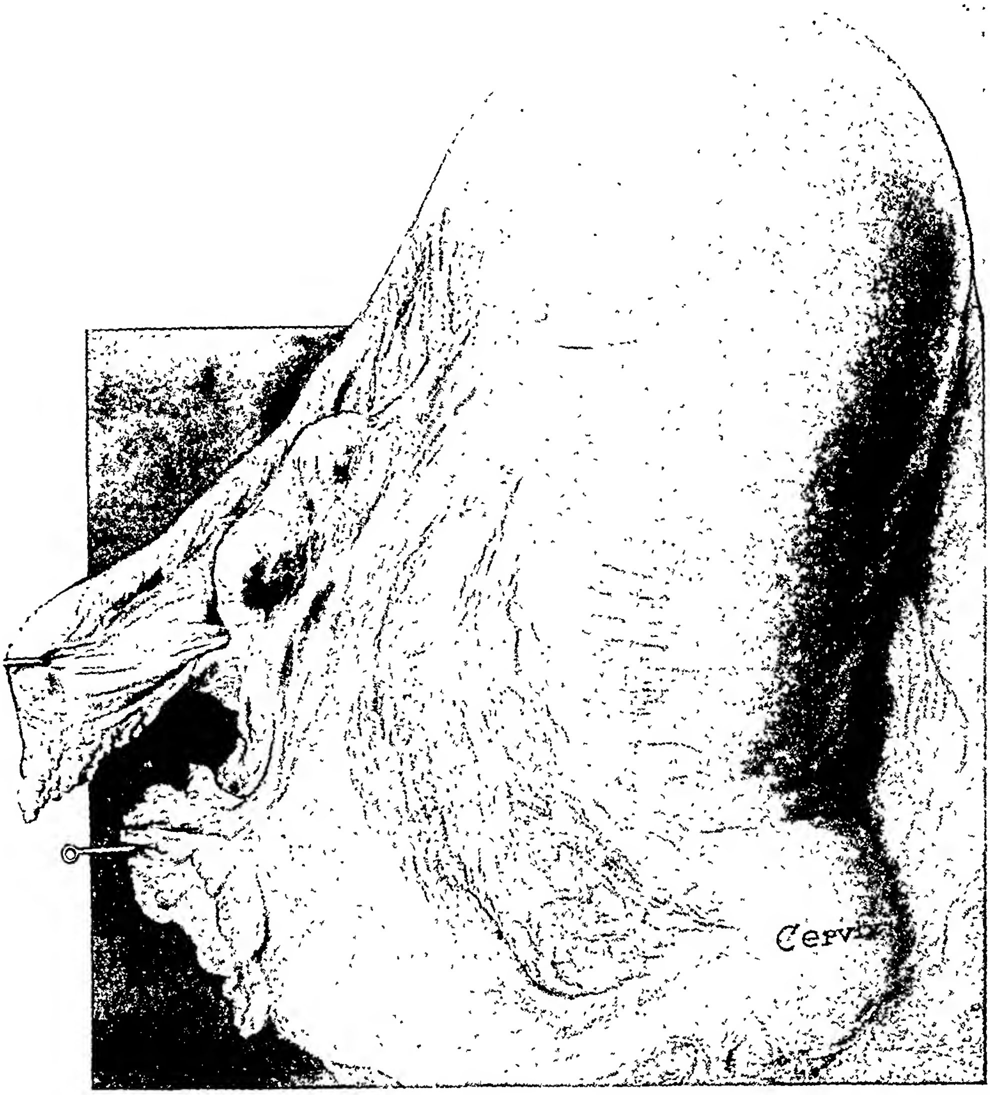

Fig. 317.—Posterior surface of puerperal uterus, showing roughened area of ectopic decidua at the posterior fold of the broad ligament.

the ovaries and culdesac constitute the favorite localities. In recent years, Geipel in Germany, and Hofbauer in this country pointed out that the omentum, the pelvic lymphatic glands, the appendix and the peritoneal covering of the diaphragm may be involved in decidual formation, which would sometimes be so pronounced as to produce papillae or flat, slightly protruding areas, or even small pale nodules varying from 1 to 3 mm. in diameter. Oc-

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CHAPTER XX

THE DIAGNOSIS OF PREGNANCY

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During pregnancy many marked changes take place throughout the body of the expectant mother. In no other physiological condition do such numerous and definite variations occur. One may point especially to the changes in the organs of internal secretion, with the resulting alterations in metabolism. From these, definite signs and symptoms develop, which aid considerably in making a diagnosis of pregnancy. The description of these changes belongs more properly in the chapter on the physiology of pregnancy; and we shall consider only those which have direct bearing on the diagnosis of pregnancy. From these changes, as well as from the development of the fetus *in utero*, certain signs and symptoms are demonstrable. These we classify as presumptive, probable, and positive signs of pregnancy. Usually the diagnosis of pregnancy is quite easy, but circumstances may develop which make the diagnosis somewhat difficult and sometimes we are unable to determine definitely whether a pregnancy exists.

Not infrequently the possibility of a pregnancy is denied by the patient and often the statement is made that a pregnancy exists when there is no pregnancy. Bumm feels that there should be a definite rule concerning this diagnosis; that is, when all available information has been obtained, a no more definite opinion should be given than the facts warrant. Often a physician will make a quick diagnosis of pregnancy on insecure evidence, and subsequently he may be forced to change his opinion.

There are occasions when the question arises as to whether or not the patient is really pregnant. Naturally this question comes up chiefly in the early weeks of gestation when we are dealing only with the presumable and probable signs of pregnancy. That this question has given considerable difficulty, is obvious from the fact that certain tests have been suggested to help in making an early diagnosis in pregnancy. Especially among these can be mentioned the tests covering the decreased sugar tolerance of the patient, the Abderhalden reaction, and finally the Aschheim-Zondek test. It can be safely said that the Aschheim-Zondek test, up to the present time, offers the most reliable information for the diagnosis of early pregnancy.

In addition to describing the various signs and symptoms of pregnancy in this chapter, I shall review the more important of these and discuss especially the development of the Aschheim-Zondek test, with its modifications.

Neu, in discussing the diagnosis of pregnancy, calls attention to the fact that in order to make an accurate diagnosis, certain questions must be answered:

1. Does a pregnancy exist?
2. Does it occur in a primipara or multipara?
3. When did the pregnancy start and when can labor be expected?

changes in shape and size of the uterus, changes in the cervix and detection of intermittent contractions of the uterus.

The positive signs of pregnancy are the hearing and counting of the fetal heart beat, the ability to outline the fetus, perception of active and passive movements, and recognition of the fetal skeleton by means of the x-ray.

Cessation of Menstruation.—In perfectly healthy married women with regular, normal menstrual histories throughout life, the cessation of menstruation is strongly indicative of pregnancy. On the other hand, this sign is not so important in cases in which there has been abnormal bleeding or periods of amenorrhea. Further, menstruation sometimes continues after pregnancy has started. Theoretically this is possible until the decidua

Fig. 318.—Hegar's sign. On careful bimanual examination, the firm cervix is felt, and above it the softened, enlarged uterus, while between the two a soft, compressible area is palpated. This sign is available at about the sixth week of gestation.

reflexa and decidua vera fuse at about the eighteenth to the twentieth week of pregnancy. Menstruation, under such conditions, is usually shortened in duration and distinctly less in amount.

In reviewing this subject, Eufinger calls attention to the fact that "amenorrhea also exists in various other conditions, in serious infections such as typhoid fever, scarlet fever, malaria, rheumatism, pneumonia, and sepsis. It may also occur in chronic tuberculosis, chronic suppurative processes in the abdomen, secondary anemia, and constitutional disorders such as diabetes, endocrine disturbances, especially of the anterior lobe of the pituitary gland, manifesting itself clinically by Fröhlich's syndrome (so-called 'dystrophia adiposogenitalis'), also in hyperthyroidism and hypothyroidism, and Addison's disease. Here also belongs the amenorrhea which may result from the

Nausea and Vomiting.—The tendency to nausea during the early morning, often with vomiting, manifests itself in a large number of pregnant women, usually about the fourth week. In some instances it may occur earlier and has been known to appear even before the first period was missed. According to DeLee, about one third of pregnant women have nausea and vomiting as a marked symptom; another third complain of them occasionally or as being inconsiderable, and about a third are entirely free of them. That these symptoms are of a nervous character is manifested by the fact that they occur more pronounced in women who are temperamental and easily excitable; therefore, they are seen more among the well-to-do than in the working classes. The author believes that individuals who know a great deal about the signs and symptoms of pregnancy, such as patients who have been trained nurses or who are physicians' wives, suffer more than those who have less knowledge of these conditions. As a matter of fact, as Williams has shown, only about 50 per cent of his private patients complain of nausea and vomit-

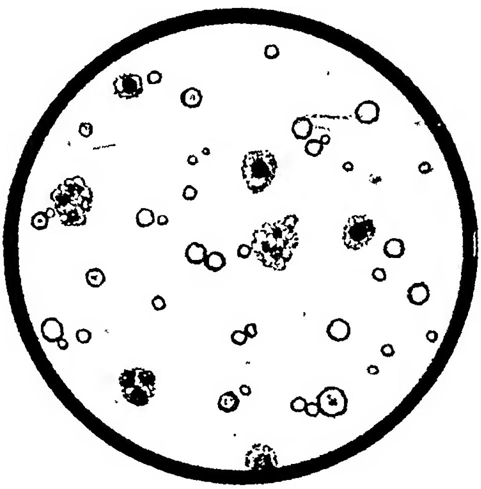


Fig. 319.—Human colostrum. A yellowish, watery fluid containing epithelial cells, leukocytes, and "colostrum corpuscles."

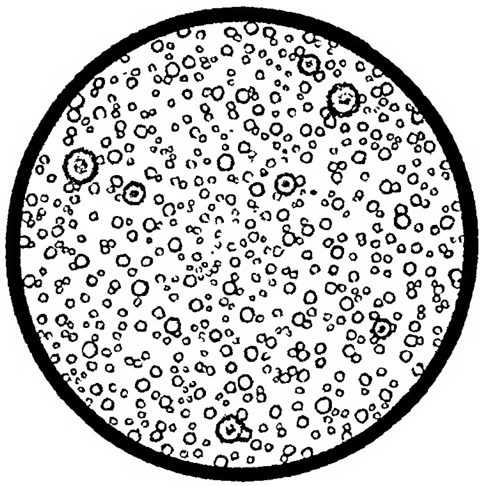


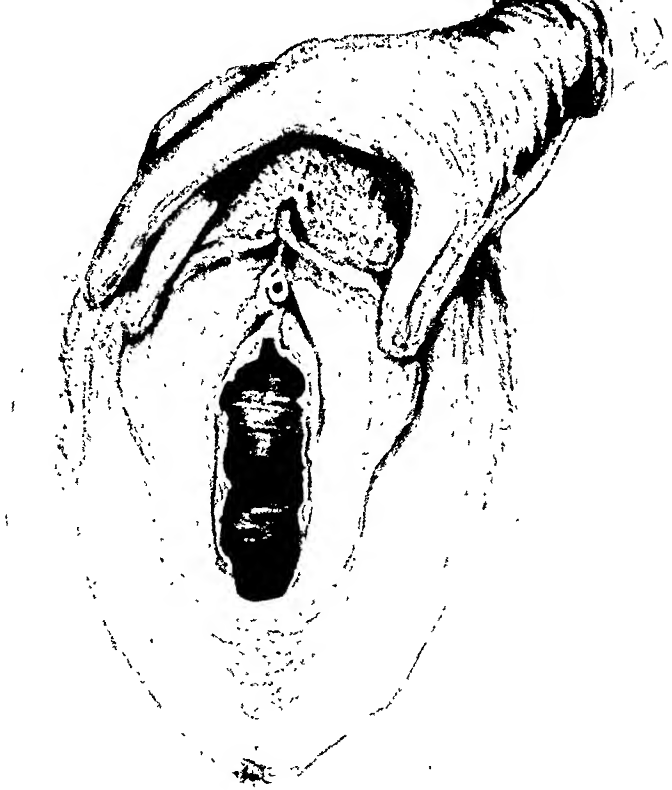
Fig. 320.—Human milk. Innumerable fat droplets of fairly uniform size with few epithelial cells and leukocytes.

ing. It is obvious why these symptoms can only be considered presumptive, from the fact that there are so many things which may cause digestive disturbances.

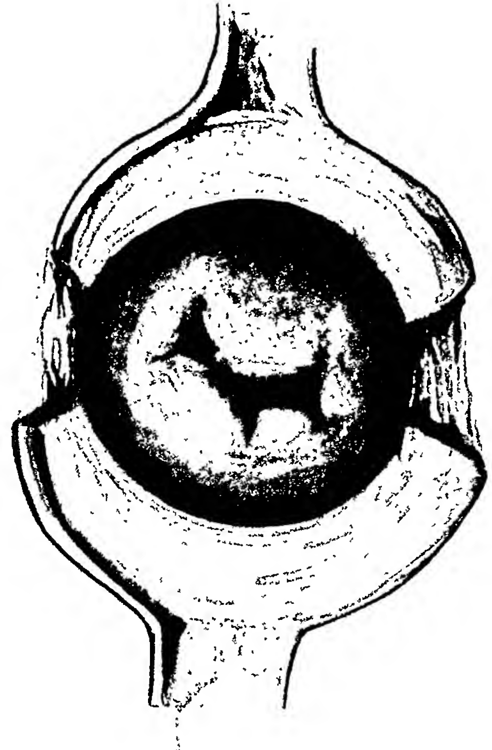
Irritability of the Bladder.—In the early weeks of pregnancy, the enlargement of the uterus causes an increased irritability of the bladder, causing a desire for frequent micturition. This symptom is present until the uterus rises well up in the abdomen, reappearing in the primipara when the head descends into the pelvis near the end of pregnancy. According to DeLee, marked anteversion of the fundus throws the cervix toward the hollow of the sacrum and stretches the base of the bladder, causing the frequency, which is so often mentioned by the gravida in the first trimester.

Fluttering Movements.—The expectant mother becomes conscious of slight fluttering movements in her abdomen about the eighteenth to the twentieth week. The term "quickening" has been given to these movements of the fetus. They have been observed as early as the tenth week and

PLATE I



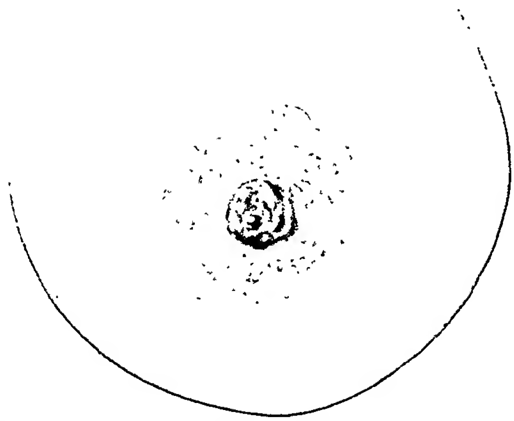
A



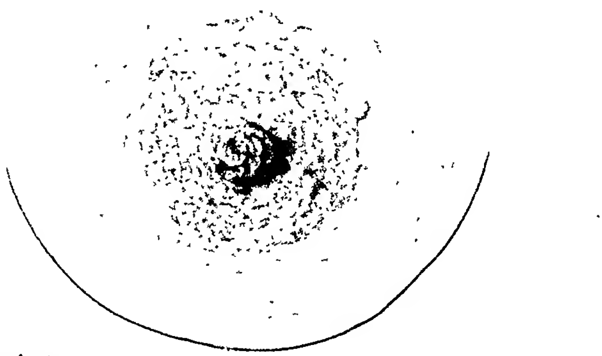
B

Chadwick's sign. A, A dark purplish discoloration of the margins of the vaginal opening and the vaginal wall. A presumptive sign of pregnancy. B, The cervix may have a congested, purplish appearance as part of the general congestion of the pelvic organs. (After Eufinger.)

PLATE II



Nipple of blonde primipara—thirty-six weeks' gestation. The deepened color of the areola is most significant.



Nipple of brunette primipara—thirty-six weeks' gestation. Around the areola, which is deepened in color there often develops another area of lighter pigmentation—the secondary areola—especially in brunettes.

bluish-pink lines. In the multipara the older striae have a silvery appearance, whereas the newer ones are similar to those seen in the primipara (Fig. 321).

According to Sellheim, the formation of these striae is due less to passive stretching than to the fact that the skin cannot accommodate itself to hypertrophic changes which occur in the abdominal walls under the influence of pregnancy. Williams states such contentions are supported by the fact that striae do not occur to such a marked degree in cases of ascites or tumor formation.

Appetite.—Many women have marked variations in their appetites during pregnancy, particularly exhibiting a strong desire for rather unusual types of food. The extreme conditions that may exist in pregnancy are illustrated by the experience of Williams with two of his patients, one of whom subsisted almost exclusively on deviled crabs throughout pregnancy, and the other could retain nothing but broiled lobster and Bass's ale during the first few months.

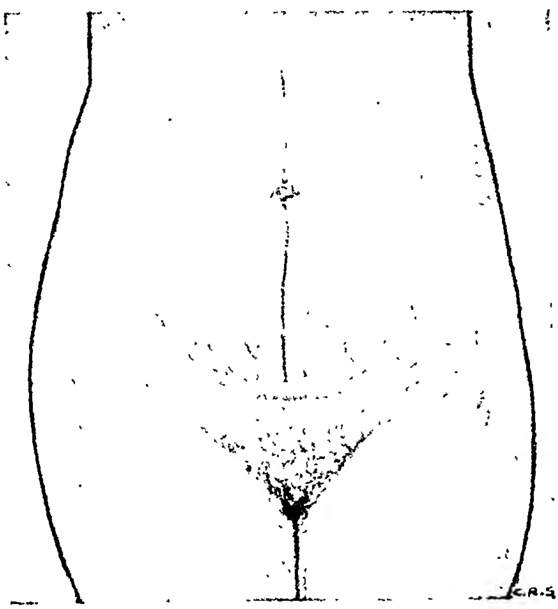


Fig. 321.—Striae gravidarum.

Mental State.—Williams also tells us of mental and emotional changes which sometimes characterize pregnancy. Occasionally women are seen who diagnose their condition chiefly from the changes in their temperaments. It is well known that pregnant women are subject to varying moods. They become hyperexcitable and have very marked changes in character, so that a quiet even-tempered individual may become complaining and irritable. DeLee states that in olden times pregnant women were considered normally irresponsible. They are not reliable as witnesses, perception being not so acute. Hysterical women suffer exaggerations of their symptoms, marked hysteria sometimes occurring. DeLee mentions that he has found many interesting phenomena in studying these cases psychologically. He thinks that pregnancy is the most momentous thing in a woman's life and her mental adjustments, happy or unhappy, to the new condition will determine her health, spiritual as well as physical. In the majority of cases the patient

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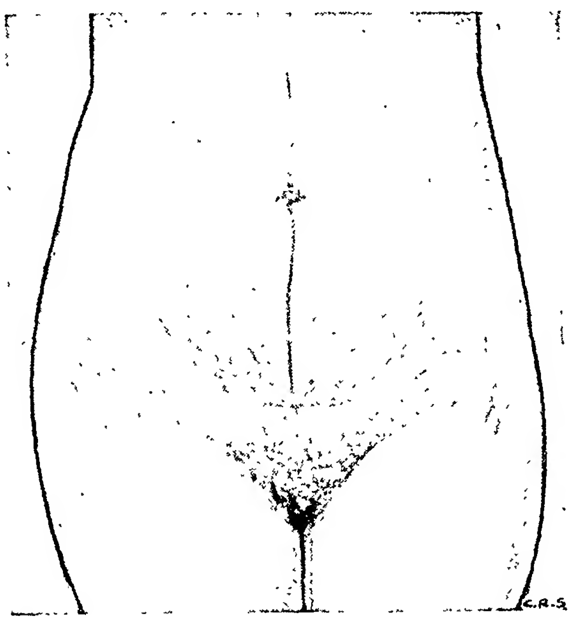

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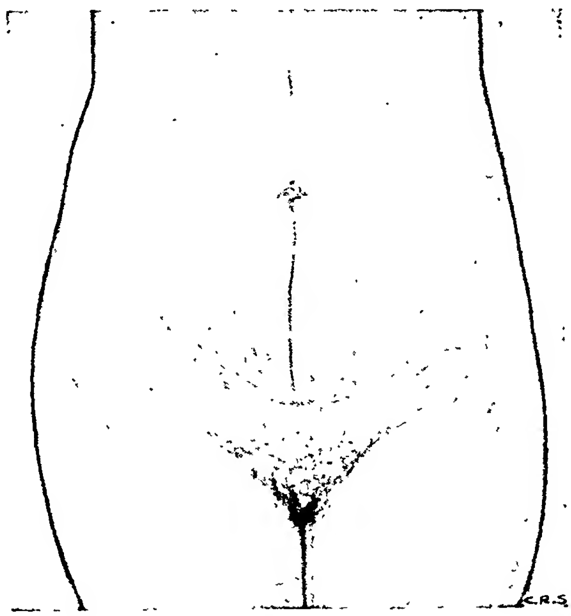

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plausible, according to Eufinger, when one considers the changes in the sympathetic nervous system and especially the increased irritability of the whole nervous system. From the study of the literature, one must conclude that this test is positive in early pregnancy in about 80 per cent of the cases and, therefore, can only be placed among the presumptive signs of pregnancy.

"(c) *Adrenalin Glycosuria.*—Subcutaneous injections of adrenalin, under normal conditions, may cause a glycosuria which, in contrast to the phloridzin reaction, has to do with primary sugar mobilization in the liver, as there usually results a marked hyperglycemia. This condition may transpire, through activity of the pancreas, as a result of stimulation of the sympathetic nervous system. The blood sugar values of pregnant and nonpregnant individuals, after adrenalin injections, rise somewhat similarly but do not quite reach the upper threshold values of the kidney. In spite of this, however, a glycosuria results on account of the increased permeability of the kidney in pregnancy. Just as in the case of the phloridzin reaction this test is not always positive, but Seitz claims that the reaction is positive in 90 per cent of the cases for the first eight months of pregnancy, whereas in the last month it becomes negative in most instances. As in the case of phloridzin reaction, here also a good many investigations have been done with some contradictory results, so that the reaction at best can only be classified as a presumptive sign of pregnancy."

The technic for the various sugar tolerance tests is given by Eufinger as follows:

Frank-Notham Test.—*Test for Artificial Glycosuria by Glucose Feeding.*—After quantitative blood sugar determinations and urine examinations for freedom of sugar, give 100 Gm. glucose in 300 to 500 cc. of tea. Catheterize. Specimen of urine taken one-half, one, and one and one-half hours later and tested for sugar in the usual manner. Then take blood sugar, by Bang micromethod which requires 1 drop of finger blood. Secretion of sugar in the urine after a given time is probably positive proof of the presence of a pregnancy.

Phloridzin Test.—Before any food is given in the morning, 0.2 Gm. of phloridzin is injected and the patient follows it with about 500 cc. of water or unsweetened tea. Thereafter the urine is collected at intervals of one-half, one, and one and one-half hours and examined for sugar. Sugar demonstrated in one of the three urine specimens indicates the probability of pregnancy.

Adrenalin Test (After Roubitschek-Brinnitzer).—Before any food is given in the morning 10 Gm. of glucose in 200 cc. of water are given, and after fifteen minutes, 0.5 mg. adrenalin 1 : 1000 is injected. As soon as sugar appears in the urine, the blood sugar content is determined after one-half and one and one-half hours. The appearance of a glycosuria with a normal or not essentially higher blood sugar content indicates pregnancy.

Abderhalden's Reaction.—The application of the Abderhalden reaction as a specific diagnostic aid to the obstetrician has been discussed since 1912. Bronfenbrenner in "The Newer Knowledge of Bacteriology and Immunology," 1928, reviews the reaction with regard to its underlying theory, technic, interpretation, and value. He states that "the cells of the body are able to assimilate only the substances present in the blood as its normal constituents. The changes brought about in the composition of the blood

As many of the products of protein digestion are optically active, their appearance in the solution results in changes in the optical activity thereof, and permits the detection of the digestive process. Because of the difficulty of preparing soluble substrata and the necessity of special apparatus, this method is not used extensively.

The reagents used, the apparatus and the actual technic have been discussed extensively (H. Schwarz and others) and have been reviewed by Bronfenbrenner.

This idea of specificity has led to an extensive literature. One large group of investigators insist that the test is not specific. Others agree with Abderhalden, who claims that errors in technic explain the findings of the objectors.

So far as the obstetrical application of the Abderhalden reaction is concerned, the consensus of opinion seems to be that whereas practically all pregnancy sera give a positive reaction, some 10 to 15 per cent of nonpregnancies, tumors, infections, etc., also give positive reactions. Bronfenbrenner concludes that "although the reliability of the results by means of Abderhalden's reaction have often been questioned, yet there exists in the literature a considerable number of reports indicating that by means of this test helpful information has been secured in a variety of conditions."

The explanation of the tendency toward specificity of the Abderhalden reaction was studied by Bronfenbrenner by methods analogous to those used in the study of immunity reaction. These experiments demonstrated that the elements of the serum which are responsible for its specificity may be removed by adsorption with a corresponding substratum in a manner analogous to that of adsorption of antibodies by the corresponding antigen. Moreover, it became evident that when the serum is thus exhausted of its specific elements by adsorption with the substratum, the ferments in the serum become active and digest the protein of the serum itself. The products of digestion obtained under these circumstances exhibit toxicity for experimental animals entirely independent of the nature of the substratum used, depending only on the nature of the serum—indicating that the serum is undoubtedly the source of the toxic digestive products.

The results of the test are considered reliable only on the condition that all the control tests performed simultaneously have given satisfactory results. Experience has shown that if all the necessary precautions and controls are carried out, the results secured by the Abderhalden reaction may be of value. However, certain errors may occur when one considers the fact that a permeable membrane and a sensitive color test are integral parts of the test. Also the difficulty in establishing proper dosages of substrata represents a weak part of the procedure. Thus, the Abderhalden reaction cannot be adopted as a routine diagnostic procedure, and should be limited to special fields of research, where it will often give valuable information.

Luttge-Mertz Test.—Luttge and Mertz, in 1924, presented a modified technic based on the principle of the Abderhalden reaction, but much simpler. In presenting this test Luttge and Mertz point out the difficulty of the Abderhalden procedure. The accuracy of their test depends almost entirely on obtaining a placental substratum which is free of amino-acids. Their method of preparing this substratum makes this possible and they have been able to report as high as 98.7 per cent correct results. The method is as follows:

for normal women to give complete sedimentation, the average time was from five to six hours. Examination of 100 pregnant women from seven to ten months' pregnant, with one exception, all showed a complete sedimentation in less than two hours. He examined a lesser number of women at four, five, and six months and also in these cases the sedimentation was never over two hours. He, therefore, states that the increased sedimentation time of red blood cells is a constant sign of pregnancy of four or more months' gestation.

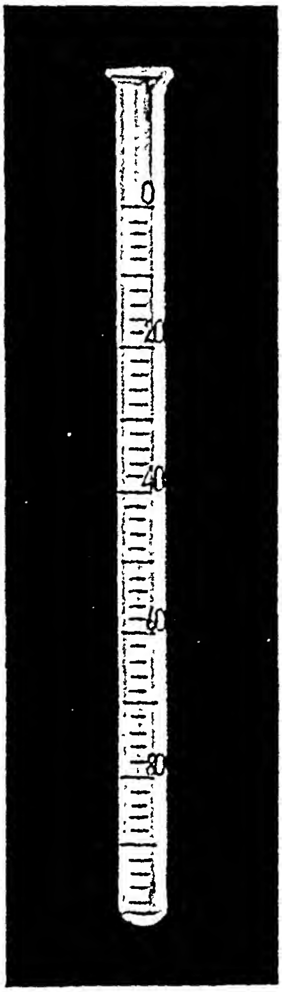


Fig. 323.—Glass tube (Plass) for sedimentation of red blood corpuscles. Graduated 1 cc. Each mark 1/100 cc.

Plass Modification.—Plass has recently modified the Linzenmeyer test, using heparin (2 mg. heparin for $2\frac{1}{2}$ cc. of blood) instead of sodium citrate, as the sodium citrate in 5 per cent solution is not isotonic. The technic of Plass is as follows:

The tube used holds 1.33 cc., and the "0" mark represents 1 cc. The remainder of the tube is graduated in one hundredths of a cubic centimeter as shown in Fig. 323.

With a pipette drawn out to a long, fine point or a 2-cc. hypo syringe with a long needle, the sedimentation tube is filled so that the meniscus is at the

column is noted on the millimeter scale. The tube is then centrifuged for ten minutes at a speed of approximately 5000 revolutions per minute, and the height of the plasma column is read again. This latter reading gives directly the percentage of plasma in the specimen, or the total possible settling in millimeters. By dividing the millimeters of clear plasma obtained after one hour of settling by the millimeters of clear plasma after centrifuging and multiplying by 100, one obtains directly the percentage of total possible settling in one hour.

Normal sedimentation time for women according to Plass' method is 30 to 60 per cent.

Normal men run from 10 to 50 per cent.

Normal pregnant women will average over 80 per cent.

Changes in Pituitary Gland.—Before considering the newer developments which led to the Aschheim-Zondek test, it is well to review briefly the changes

A B

Fig. 326.—A, Corpus luteum. B, Lutein cells, high power. Chiefly under stimulation of the prolan B hormone of the anterior lobe of the pituitary the corpus luteum develops.

which take place in the pituitary gland during pregnancy. In addition to this, we have presented a series of illustrations which serve to explain the changes which result from the action of the pituitary hormones on the ovaries and uterus in the human (Figs. 324–327).

During pregnancy, the anterior portion of the pituitary gland undergoes marked changes. Comte was the first to describe the enlargement of the gland, especially of the anterior lobe. The most exhaustive investigation of this subject was published by Erdheim and Stumme in 1908. They reported their findings in a series of 150 pituitary glands. A confirmation of these results was published by Kolde in 1912. The increase of volume of the pituitary, according to these writers, is two and one half times the normal weight, in actual weight 1.06 Gm. After removal of the brain at autopsy the gland protrudes markedly from the sella turcica.

may have become contaminated and so carry infection into the birth canal. If all these clinical evidences are present, it may be properly assumed that the placenta has completely separated.

Extrusion of the placenta, which in the primitive type of woman usually follows immediately after separation, is accomplished by the identical kind

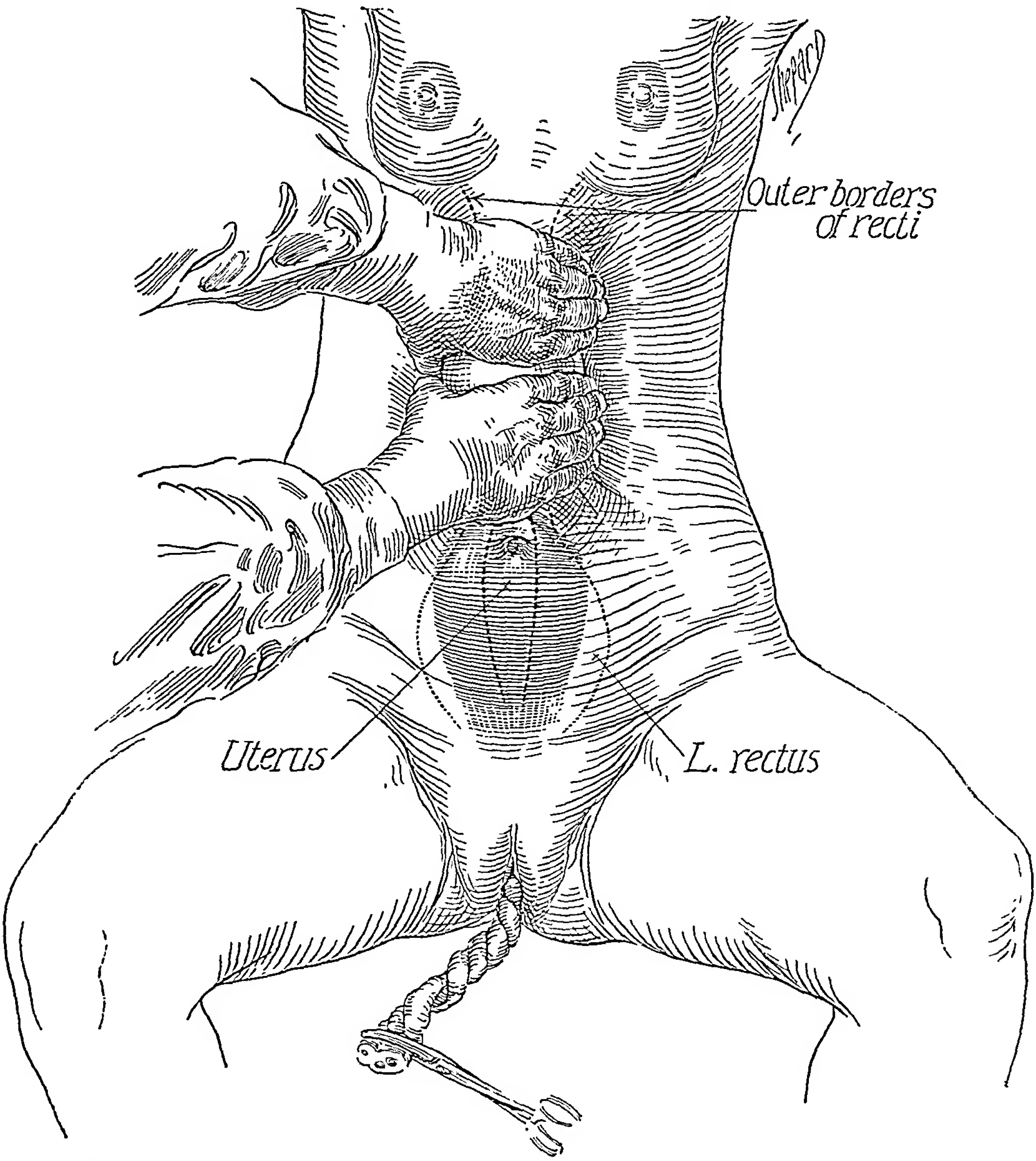


Fig. 443.—Indirect expulsion of the separated placenta. The abdominal recti are grasped at the outer margins in the upper abdomen when the uterus is in firm contraction. They are pulled together toward the midline and held while the patient makes a single vigorous bearing-down effort.

of bearing-down or expulsive effort as was applied toward the expulsion of the fetus. In modern obstetrical practice little has occurred which should interfere with the normal spontaneous act of separation, but much has occurred which prevents spontaneous extrusion of the placenta. The patient is in bed instead of squatting; she is frequently not of the hardy physical

If this does not occur, the author's method of "indirect expulsion" should be attempted.[4, 5] For each of the various methods to be described the bladder should be empty or catheterized, the uterus must be in firm contraction and must be in the midline over the inlet. If the evidences of complete separation are positive and the patient is alert and cooperative, "indirect expulsion" (Baer) may be achieved by a temporary reconstruction of the tone of the abdominal wall. The abdominal recti are grasped at their outer margins in the upper abdomen at a moment when the uterus is in firm contraction. They are pulled together toward the midline and held while the patient makes a single vigorous bearing-down effort. This reinforcement of the abdominal wall enables her in 90 per cent of the instances to achieve a so-called "indirect expulsion of the placenta." This obviates grasping and perhaps unnecessarily mauling the uterus.

If the patient's cooperation cannot be had and separation has occurred, the firmly contracted uterus may be used as a plunger to drive the placenta out of the birth canal (simple expression). This is done by placing four fingers of one or both hands behind the uterus through the indented abdominal wall, the thumbs resting on the anterior surface. At the height of a strong contraction the uterus is pushed (not squeezed) downward in the axis of the inlet and the placenta is expelled. Failure usually means that separation was wrongly diagnosed.

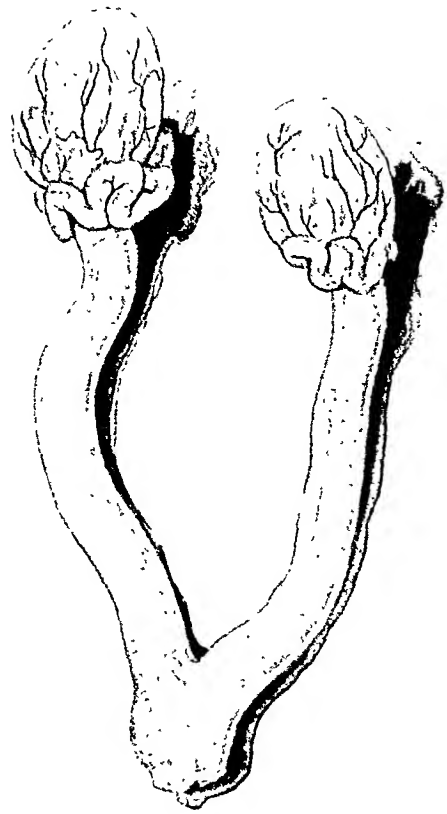
If, after half an hour of waiting, which is entirely permissible provided there has been neither excessive hemorrhage nor shock, it is found that the placenta is not yet separated, then and only then should the "Credé method" of expression of the placenta be employed. This requires that the grasp just described for simple expression of the separated placenta may be employed on the *firmly contracted* uterus, not in a downward propulsion, but in a compression of the corpus especially at its highest point in the abdomen in order to squeeze the retained placenta out of the corpus cavity. When this is accomplished, the placenta is then delivered by a downward push as described for simple expression.

Massage of the uterus has no place in the normal third stage of labor. If separation of the placenta is long delayed, gentle friction of the back wall of the uterus is legitimate to bring on the firm contraction which is necessary before the Credé method can be attempted. Massage may be valuable in the presence of postpartum hemorrhage if it becomes necessary to empty the uterus rapidly (see Postpartum Hemorrhage).

The normal duration of the third stage may be from a few minutes to as many hours as are necessary finally to accomplish the delivery of the placenta by any of these methods. It has been found safe[15, 16] to amputate the cord flush with the cervix and allow the uterine contents to remain undisturbed for as long as twenty-four hours. Common practice, however, justifies termination of the third stage by a manual removal of the placenta after two hours. During this period of waiting, the assumption being that the placenta has not yet separated, the Credé method may be used not oftener than once every fifteen minutes and only at a time of firm contraction.

Waiting is infinitely preferable to and safer than too frequent or too violent attempts at Credé expression or manual removal. While waiting, however, the condition of the patient must be closely observed for evidences of hemorrhage or shock. The former may be external and obvious or concealed

PLATE III



a

b

Aschheim-Zondek reaction in the mouse. (Preparations made by Dr. H. Stricker, Munich.) *a*, The normal mouse; *b*, positive findings. Note blood points and atretic corpora lutea. (From DeLee, "Principles of Obstetrics.")

becomes noticeable about the sixteenth week when the fundus can be felt well above the symphysis. The enlargement is less pronounced in the primipara than in the multipara, due to the fact that the abdominal walls of the primipara have more tone and hold up the growing uterus better. The relaxed abdominal wall of the multipara causes a marked bulging which at times may become definitely pendulous. The accompanying diagram (Fig. 333) shows the proportionate increase in the uterus during the various weeks of pregnancy.

Enlargement of the Uterus.—The uterus is the most markedly altered organ in early pregnancy. The normal nulliparous uterus measures about 7 cm. in length, 4 cm. in width, and 3 cm. in thickness. The enlargement is

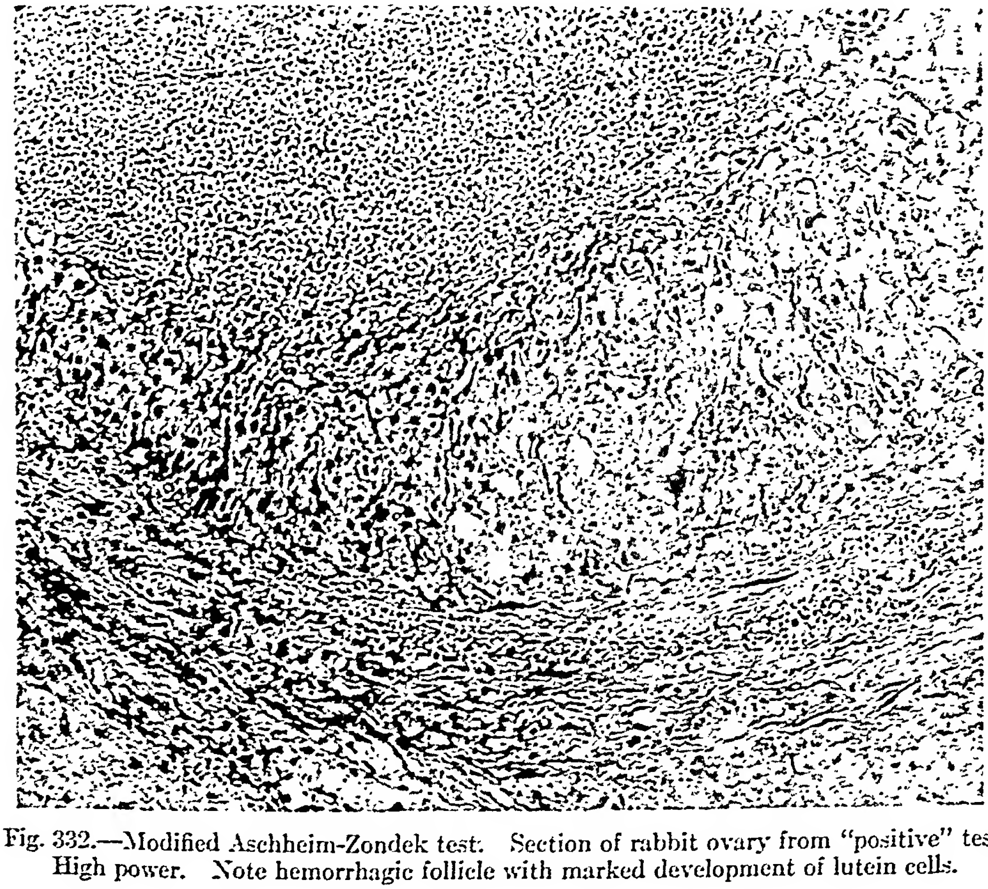


Fig. 332.—Modified Aschheim-Zondek test. Section of rabbit ovary from "positive" test. High power. Note hemorrhagic follicle with marked development of lutein cells.

appreciable definitely by the end of the first month, as are the changes in consistency and shape. The implanted ovum distends that portion of the uterus where it is situated. This is usually on the anterior wall. If implantation takes place near either opening of the tube, the uterus becomes asymmetrically enlarged, giving the suggestion at times of an interstitial pregnancy. (See illustration of Piskacek's sign, Fig. 334.) DeLee refers to this asymmetry by the French term of "grossesse angulaire" (Fig. 334).

Hegar's Sign.—Perhaps the most striking of all changes is the softening of the uterus at the isthmus just between the cervix and the body. This was especially emphasized by Hegar, who by bimanual examination demonstrated this softening. This change in consistency can be demonstrated as

Changes in Cervix.—The cervix increases in size during pregnancy as a result of hypertrophy of the muscle fibers, just as does the body of the uterus. There is an early edema and loosening of the connective tissue, which causes the softening of the cervix. As a result of the activity of the cervical glands, there is a marked amount of mucus produced which first appears in the canal, causing complete stenosis. Williams states that prior to 1927, the only marked change in the cervix that was usually mentioned was the softening. He also states that the cervical mucosa undergoes such marked proliferation that at the end of pregnancy it occupies half of the entire cervix instead of a small fraction as at other times. A honeycomb-like structure develops, the meshes of which are filled with tenacious mucus.

Braxton-Hicks Sign.—Intermittent contractions of the uterus were first described by Braxton-Hicks in 1872. Williams remarks that although all these contractions are quite characteristic and more readily elicited during pregnancy, it has been shown by Sun, in his clinic, that the human uterus, whether pregnant or not, is constantly undergoing contractions. These movements have also been observed in cases of hematometria as well as in cases of soft myomata of the uterus. Contractions occur at very irregular intervals, the frequency varying with the individual case. Sometimes they occur only once in a few days and at others they can become so marked that they simulate the contractions of early labor. In some multiparae, the contractions are very frequent and quite marked, so that they become more or less annoying to the patient and make her rather uneasy as regards whether she actually is in labor or not. In some multiparae these contractions become so marked that they cause the patient a considerable amount of discomfort during the latter months of pregnancy.

Fetal Heart Beat.—From the fetus, one hears the heart beat (fetal pulse). Bumm tells us that M. Major, a surgeon of Geneva, first emphasized this as an unmistakable sign in 1818. Independently, Lejuneau de Kergeradek, through a contribution at the Academie de Medecin in 1822, also reported the importance of the fetal heart beat as a positive sign of pregnancy.

At about sixteen to twenty weeks, the fetal heart beat can be heard through the abdominal wall as a simple systolic tone, and later as a double tone similar to the tone of the adult heart. Experienced observers, as Sarwey has shown, with repeated examinations have demonstrated the sounds as early as the twelfth week. The frequency of the fetal heart beat is between 120 and 160, with an average of about 140 per minute. It rises with the movements of the fetus and drops during the uterine contractions. Like all phenomena of sound, the heart sounds are transmitted better through the tissues than through fluid. Therefore, the heart sounds are heard best where the fetus lies closest to the uterine wall. At such places where there is a layer of amniotic fluid between the fetus and the uterine wall, the sounds are only heard weakly and if the amount of amniotic fluid is considerable and surrounds the fetus on all sides, it may hinder the perception of the fetal sounds entirely. In certain areas the intensity of the tone increases with the nearness of the fetal heart; accordingly, one may determine the place where the fetal heart sound is heard loudest for all fetal attitudes. With the typical flexion of the fetal body, the back approaches the uterine wall more closely. The heart sounds are heard through the back of the fetus, but they are heard loudest through the anterior portion of the chest because of the close proxim-

tient. The two hands encircle the upper portion of the fundus to determine the character of the fetal parts in that vicinity. The head, characteristically rounded, is readily ballottable in breech positions and the breech irregular, soft, and less ballottable in vertex presentations. The second maneuver is a continuation of the first, with the hands sliding down beside the uterus. In this way the location of the small parts and the back are readily elicited. In the third maneuver, the right hand is placed over the symphysis to feel the relationship of the presenting part to the pelvic brim. If the head is movable,

Fig. 342.—Roentgenogram, fifteen and a half weeks' gestation. (Courtesy of Dr. P. C. Schnoebelen.)

the fourth maneuver is not necessary. The fourth maneuver is carried out with the examiner changing his position and facing the patient's feet. He then uses two hands in outlining the presenting part. In case of an ordinary normal vertex position, the cephalic prominence will be felt higher on the side of the chest down to the marked flexion of the head. In the abnormal face presentation, the cephalic prominence can be easily demonstrated by this maneuver on the same side as the back due to the extension of the head. The accompanying diagrams (Figs. 338–341) illustrate these procedures.

latter part of pregnancy may be expressions of a more or less severe, but usually transient, asphyxia of the fetus.

Roentgenography.—This has been shown to be valuable in obstetrics in the diagnosis of pregnancy in obscure cases, in the recognition of multiple pregnancies, for the diagnosis of abnormal positions of the fetus, in the differentiation between pregnancy and tumors, and in revealing the presence of monsters.

Although individual nuclei of ossification centers of the fetal skeleton may be recognized as early as the sixth or seventh week of gestation, radiological diagnosis is not certain until the second trimester of pregnancy. Sante reported a case of visualization of the entire fetal skeleton at ten and one-half weeks' gestation. The illustration in the text was taken at fifteen and one-half weeks. K. Warnekros has demonstrated the various fetal positions, progress of labor from onset to delivery and methods of expulsion of the placenta with *x*-ray photographs (Figs. 342, 343).

Peterson states that "the pneumoperitoneal roentgenogram has been extremely valuable as an aid to diagnosis in early cases of pregnancy—from the sixth to tenth week. In 8 cases from the sixth to the tenth week, the condition was positively diagnosed by roentgenogram and in each instance the diagnosis was confirmed by the subsequent history.

"The roentgen picture of early pregnancy shows almost uniformly an enlargement of the isthmus, the cross section of the uterus at a point corresponding to the lower uterine segment. Not only is the isthmus enlarged in the long axis of the uterus but it is shown to stretch out on the sides toward the broad ligaments. Beyond the tenth week, this thickening of the isthmus is very marked and pregnancy can invariably be recognized by pneumoperitoneal film at a time long before fetal bones can be demonstrated."

Diagnosis of Previous Pregnancy.—There are definite distinctions between first and subsequent pregnancies. This differentiation is sometimes important. Usually childbearing leaves certain definite traces on the individuals to mark them as women who have borne children. In some instances these markings are so slight that they apparently are lacking. It is sometimes a matter of importance to decide whether the woman is pregnant for the first time or has already borne children. These changes are best contrasted in the table (page 672), by Eufinger, after Sellheim.

Duration of Pregnancy.—The author has just reviewed the subject of the duration of pregnancy elsewhere and takes the liberty of quoting freely from this article.

The rather loose term "duration of pregnancy" is usually considered to be from the beginning of the last menstrual period until the day of delivery. This, usually, is said to be about two hundred and eighty days. Pregnancy actually begins the moment that the female egg cell becomes fertilized and ends with the birth of the child. The time estimated as the absolute length of pregnancy is rather difficult to determine on account of several variable factors: (*a*) The question of the time of ovulation; (*b*) the time of migration; (*c*) the lifetime of the egg and the spermatozoa; (*d*) the time of impregnation, and (*e*) the time of implantation of the ovum.

(*a*) The time of the follicle rupture in the ovary is not constant, but covers a period of several days. Formerly it was believed that ovulation and menstruation occurred simultaneously, but Frankl was first to show by the

but ovulation may occur rather late, between the fifteenth and the thirtieth day.

Newell and Allen recently devised a method of recovering the extruded ovum from the tube, studying the question of polar body formation and also the condition of the corpus luteum. They felt from the condition of the ovum and the character of the corpus luteum, which were removed at operation, that ovulation takes place on the fourteenth day of the cycle. In reviewing this subject, Kehrer believes that the physiologic period is about a week and that the fifteenth day of the cycle may be considered the most frequent. He also calls attention to the fact that in a twenty-one-day cycle, the average time for ovulation is about the tenth to the twelfth day after the first day of menstruation.

(*b*) The time it takes the extruded ovum to reach the fallopian tube is not definitely known. It is, however, dependent on two functions of the tube, first the action of the cilia and second the peristalic waves. Obviously, the ovum will travel faster through the wider ampulla than through the narrow isthmus. This has been demonstrated in animals. It has been well established in animals that the ovum gets into the tube shortly after expulsion, in guinea-pigs in less than twenty-four hours, in most species from two to three days. In dogs it has been shown about as long as ten days. Grosser and Ruge feel that the human egg can live in the tube several days and still become impregnated. From the study of Newell and Allen, five ova were recovered in the tube between the twelfth and fifteenth days. Three showed formation of the first polar body, and one definite formation of the second polar body. The finding of so-called *cell balls* in the tube after this length of time would indicate that tubal ova probably degenerate by the twenty-first day of the menstrual cycle and are probably incapable of being fertilized in most instances after that time.

(*c*) For the discussion of the duration of pregnancy, information concerning the migration time and the life period of the spermatozoa is of importance. The spermatozoa in the vagina in physiologic conditions are subject to a more or less acid reaction, and then in the cervical canal they must make their way through the rather thick alkaline secretion. With the head pointed toward the tubes they reach the tube and must travel against the movements of the cilia. Experimentally, in dogs, Haussmann found spermatozoa in the tubes one hour after intercourse. In humans they can be readily demonstrated in the tubes in twenty-four to thirty-six hours. That would be the least possible time between intercourse and impregnation. The duration of life of the spermatozoa indicates that they have more vitality than the ovum.

Hoehne and Behne have established the fact that the movements of the spermatozoa are lost after one hour in the vagina, which has a markedly acid reaction, whereas in cases where the vaginal secretion is only slightly acid, they have been found as long as two days afterward. The duration of life of the spermatozoa in the tube has been rather clearly demonstrated in animals. Bischoff found spermatozoa in dogs from eight to ten days, Hensen in rabbits from four to six days. Hirshfeld, at autopsy, found them alive one to two days after intercourse. According to Hoehne and Behne, three days is the lifetime of the spermatozoa in the tube. By special technic, Nürenberger found living spermatozoa in the tube fourteen to fifteen days

deviation between first and later pregnancies. Age of the mother seems likewise to be without effect.

"In support of the argument from analogy with cows, horses, and other animals, that individual mothers differ greatly from each other, in average length of pregnancy, we prove from the records of 98 individual mothers who were delivered of more than one child at Lane Hospital in San Francisco that the differences between the average pregnancy duration of individuals are significantly greater than the differences between the various pregnancies of each individual.

"Contrary to the belief of some writers that the frequency curve of durations is normally distributed, with just as many deviations of each magnitude on one side of the mean as on the other, we find that it is really far from normal, with the cases concentrated about the mean in such a way as to indicate some variable disturbing factor other than the date of impregnation.

"In fact, it appears from the shape of the curve that it is safe to assume in predicting the time of birth that the birth is more likely to occur *before* the average time than *after* it.

"A large part of the abnormality of the curve may be explained on the hypothesis that approximately 10 per cent of the menstruation-to-birth durations were really one month longer, due perhaps to a 'false menstruation' occurring after pregnancy had actually begun. But in order to make these actual durations fall into a theoretically normal distribution, it must further be assumed that the 'false menstruation' occurred not twenty-eight days after the last true menstruation, but thirty-two to thirty-five days later."

Pseudocyesis or spurious pregnancy, which is an imaginary pregnancy, occurs from time to time. This condition is characterized by signs and symptoms which frequently rather closely simulate those of normal pregnancy.

My associate, Paddock, has recently reviewed this subject in an excellent article. He states that spurious pregnancy is referred to by a number of terms, such as false pregnancy, phantom pregnancy, imaginary pregnancy, hysterical pregnancy, and simulated pregnancy. From his observations and in reviewing the literature, the cases described fall under three general types: First, those women in whom there is a decided fear of pregnancy or in whom there is an aversion to pregnancy; second, women who are extremely desirous of becoming pregnant; third, those in whom pregnancy is imagined because of some functional disturbance attended by symptoms which simulate the signs or symptoms of normal pregnancy.

Kehrer states that the condition has been known since ancient times. It is most frequently seen in women well advanced in active sexual life and usually occurs after the age of thirty, in women who have been married many years and have had no children. It is sometimes seen near the menopause, especially in women who experience this prematurely. Cases have been reported in patients several years after the menopause, and Kehrer mentions that Earle has reported a case in a woman sixty-six years of age.

In every case of imaginary pregnancy, a combination of somatic changes and psychic influences can be demonstrated. The chief alteration of a bodily character is an increase in fat. This is more or less general, noted especially over the abdomen, the breasts, the thighs, the gluteal region, and the vulva. Some individuals even complain of difficulty in walking and breathing. In

7. Bronfenbrenner, J.: Abderhalden's Dialysis Reaction and Theory of the So-called "Protective" Ferments, Chapter LXXIX, p. 1056, The Newer Knowledge of Bacteriology and Immunology, The University of Chicago Press.
8. Brown, T. K.: A Proposed Modification of the Aschheim-Zondek "Pregnancy Test," Amer. Jour. Obst. and Gyn., vol. xxiii, No. 3, p. 379, March, 1932.
9. Zondek, B., and Aschheim, S.: Klin. Wchnschr., 6, 248, 1927.
10. Aschheim, S.: Deutsche med. Wchnschr., 53, 45, 1927.
11. Zondek, B., and Aschheim, S.: Klin. Wchnschr., 6, 249, 1927.
12. Aschheim, S., and Zondek, B.: Klin. Wchnschr., 7, 1404, 1928.
13. Schneider: A Hormone Test of Early Pregnancy, Surg., Gyn., and Obst., 52, 56, 1931.
14. Paddock, R.: Spurious Pregnancy, Amer. Jour. Obst. and Gyn., xvi, 845, 1928.
15. Lewis and Wells: Amer. Med. Jour., 78, 863-865, 1922.

If any pelvic operation has been performed its character should be known and as much as the woman can tell about findings and technic. Sometimes a letter to the surgeon is of use. The obstetrician is frequently handicapped by the many pelvic and plastic procedures which have been carried out by men who apparently had little interest in the effect of these operations upon subsequent pregnancy and labor.

The history of previous labors is of great importance. If there has been normal delivery of a child or children of average or more than average weight after labors of average length the probability of another normal labor is strong. The cause, character, and management of any dystocia should be inquired into.

Obstetric injuries, postpartum hemorrhage, and sepsis after labor are of importance.

Repeated attacks of tonsillitis and infections of the accessory sinuses of the nose are of importance. Dental infections and the presence of dead teeth are especially to be noted.

Record Card.—A record should be made of the history and results of examination. A convenient form of record is illustrated on page 680.

General Physical Examination.—The heart should be carefully examined, its borders, rapidity, and regularity being noted. Any murmurs which may be present should be carefully considered, but it must be borne in mind that the mere presence of a murmur is not, *per se*, of first importance. It is quite possible for a murmur to be present with compensation perfectly maintained. If no signs of decompensation are present, such as dyspnea on effort, ankle edema, and moist sounds at the bases of the lungs, it is quite likely that the pregnancy will proceed safely. The influence of various types of heart disease upon pregnancy will be considered in another chapter.

Examination of the lungs will disclose the presence of any respiratory infection as well as the evidence of any previous extensive tuberculous infection. Should pronounced cardiac or pulmonary symptoms be found it may be wise to enlist the aid of an internist.

The importance of focal infections during pregnancy has in late years more and more impressed men who are doing careful obstetrics. A painstaking search for foci should be made. The tonsils should always be inspected and if infection in these or in any of the nasal sinuses is present it is well to refer the patient to a laryngologist. The teeth should be examined carefully and the patient's attention called to any evidence of dental infection or cavities. If possible her dentist should also see her and when indicated *x*-ray examination of the tooth roots should be made. There should be no hesitation in correcting any dental trouble. Extractions may and should be done if needed, preferably by a dentist who has developed especial skill in this work. Local anesthesia is perhaps better for this than gas as the extraction may be done more slowly and with less trauma. Abortion following extraction of a tooth is exceedingly rare. In the experience of the writer covering many scores of extractions during pregnancy it has never occurred.

A blood count and estimation of hemoglobin forms a part of the first examination. The blood changes in normal pregnancy will be discussed later. If any reason for suspecting specific infection exists a Wassermann test should also be done. It is always well to err on the side of safety. Unnecessary Wassermann tests do no harm but an unrecognized syphilis is a

point to hold the pad, is all that is necessary. The binder may be applied loosely.

The regaining of normal muscle tonus depends primarily upon the amount of stretching which the abdominal structures have undergone and upon their own reparative power. If great stretching has occurred and marked loss of tonicity has in consequence been brought about, it is impossible to restore the abdominal wall completely to its former state.

Exercises of the abdominal muscles, which may be begun after the second week, may help. Massage may also be used but it is best to tell the patient quite frankly that a complete restoration of her former waist measure may not be possible.

Care of the Bowels.—It was for many years the custom to give every woman a cathartic on the morning after delivery. Castor oil was widely used for this purpose. The discontinuance of the practice did not exercise an evil influence upon the character of the puerperium, indeed, McPherson[28, 29] found that a series of puerperae who had had the routine dose of castor oil did a little less well than a similar series from whom it had been withheld. Apparently the absence of vulvar contamination with fluid feces following active catharsis lessened the number of low-grade fevers in the early days of the puerperium. Again, the placing of the convalescent woman upon the bed pan, perhaps repeatedly, on the morning after delivery, together with the depleting effect of watery catharsis, subjects her to needless exhaustion. Cathartics during recovery from labor should not be routinely used but should be given when definitely indicated.

Enemas are to be used when spontaneous evacuation of the bowel does not occur. It has been the custom in some maternities for each woman to receive a daily enema. This is neither necessary nor desirable. It is best to promote bowel action by the additions of bulk foods to the diet, which in most cases may be done quite early, and by the giving of some one of the preparations of mineral oil. Occasionally some abdominal distention may occur within the day following delivery. This seems to be at least partly due to the sudden diminution in bulk of the uterus and consequent lessening of crowding of the intestinal coils. It as a rule disappears of itself and, unless extreme, needs no attention. Should it be quite marked, or should the woman suffer discomfort from it, an enema will usually relieve it. The reestablishment of a regular bowel habit should be brought about as soon as possible.

Many woman complain greatly of hemorrhoids after delivery. In many instances these were already present during pregnancy, being caused by the interference with return circulation from the lower part of the body by the heavy and bulky pregnant uterus. The straining efforts of labor aggravate them and they may be very troublesome. As a rule the relief of pressure upon the pelvic veins favors a spontaneous improvement and after a few days the condition improves greatly. The use of hot applications will sometimes give relief. If the condition is aggravated, and large turgid, perhaps strangulated hemorrhoids, or hemorrhoids into which bleeding has occurred, are present, more radical treatment may be needed. A proctologist may be of great assistance in some cases.

Care of the Breasts.—During pregnancy the breasts have increased in size and have become heavier. During the last few weeks of pregnancy, and in some women earlier, it is possible to express from the nipples a thin

the pelvimeter arms are pressed firmly against them, and the measurement is read off. It should normally be 26 cm.

The Distance Between the Iliac Crests, or the Intercristous Diameter.—The most widely separated parts of the iliac crests should be sought and the edges carefully located; the tips of the pelvimeter are then closely applied to the outer edges. The average length of this diameter is 29 cm. The thickness of the iliac crest is from 1.5 to 2 cm. The inner lips are, therefore, separated from one another by a distance which is 1.5 to 2 cm. less than the intercristous diameter.

The Distance Between the Trochanters or the Bitrochanteric Diameter.—The woman is asked to place her legs close together with feet held in contact

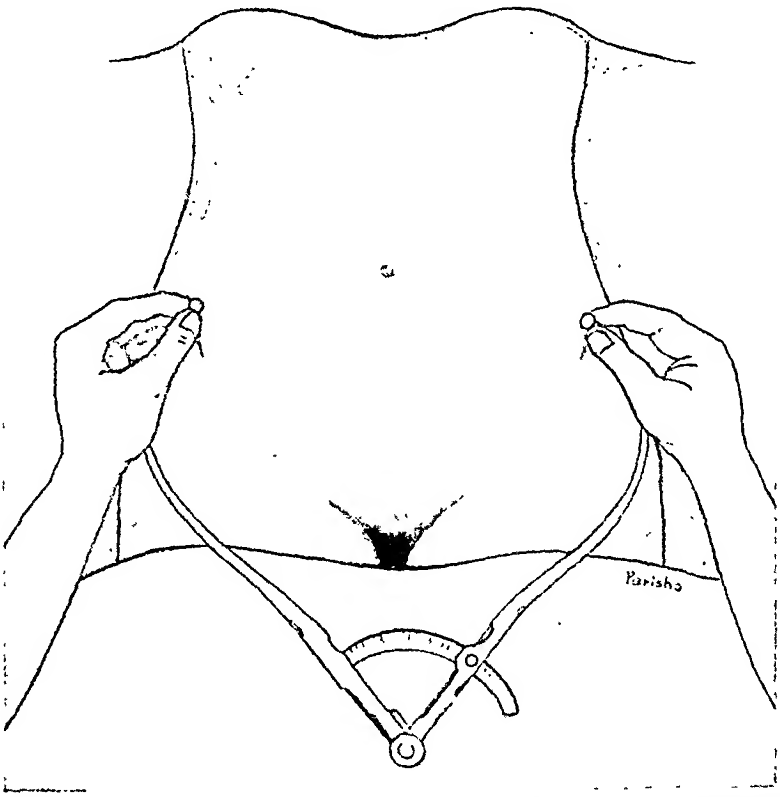


Fig. 346.—Taking the interspinous diameter. (Redrawn from Williams.)

with one another. The trochanters are located with the fingers and the measurement obtained as described above. This diameter averages 32 cm.

Of the external measurements this is the least important. It is caused to vary by the thickness of the soft tissues over the trochanters which in fat women may be considerable, and also by the angle which the neck of the femur makes with its shaft. The neck of the femur, too, may vary somewhat in length.

The External Conjugate or Baudelocque's Diameter.—This extends from the depression under the last lumbar vertebra to the upper part of the anterior surface of the symphysis. A dimple is usually found just under the last lumbar spine. This forms the upper angle of a rhomboid, its lateral extent

uterus is in normal position, whether the perineum has healed well in case any repair has been done, and whether any notable damage to the cervix remains. This should be done with the utmost gentleness in order that the pelvic structures may be disturbed as little as possible. If infection is present examination should be omitted. A simple rectal examination will afford sufficient information except as to the cervix and is preferred by some obstetricians.

If a retrodisplacement is present the young mother should be asked to assume the knee-chest position twice daily for ten minutes each time. It is always well to show her how this is done, or have her instructed by a nurse who knows what the knee-chest posture is. Otherwise she is almost certain to assume a faulty attitude. As an alternative to this, if she cannot take the knee-chest position, the "monkey walk" may be suggested. The woman walks upon her hands and feet, the knees and elbows being held straight. The knee-chest position is of service in the majority of cases and in a fair number of instances suffices alone to cause a uterus which is retrodisplaced

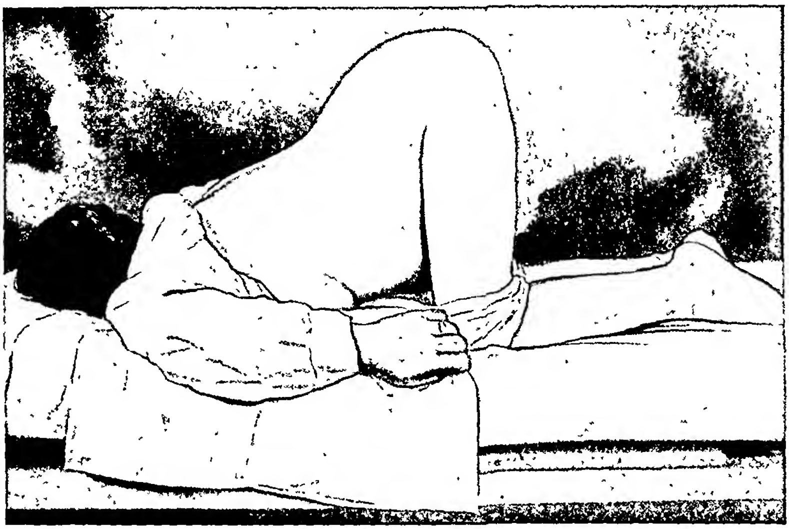


Fig. 455.—Knee-chest position. (DeLee, "Principles of Obstetrics.")

at the time of discharge from the hospital to be found in anteflexion a month later. Should the uterus be found in the backward position at the time of the final examination it should be manually reposited and held in anteposition by a pessary for a period of two months. A week after the pessary is put in it is wise to reexamine to be certain that it is not causing undue pressure anywhere and that it is holding the uterus in proper position. It should be removed at the end of a month for cleansing and to permit inspection of the vaginal mucosa for possible damage from pressure, and then replaced for another month. In a series of 1000 private cases studied by Danforth and Galloway,[9] retrodisplacement was found either during pregnancy or the puerperium in 18 per cent. It is always well to replace a retrodisplaced uterus as the backward position causes a passive hyperemia which hinders the process of involution. Bleeding during the puerperium is occasionally caused by this condition and a reposition of the uterus may, without further treatment, be sufficient to control it.

The diagonal conjugate is measured. The elbow should rest upon the knee, the foot being upon a low stool or upon a step attached to the table.

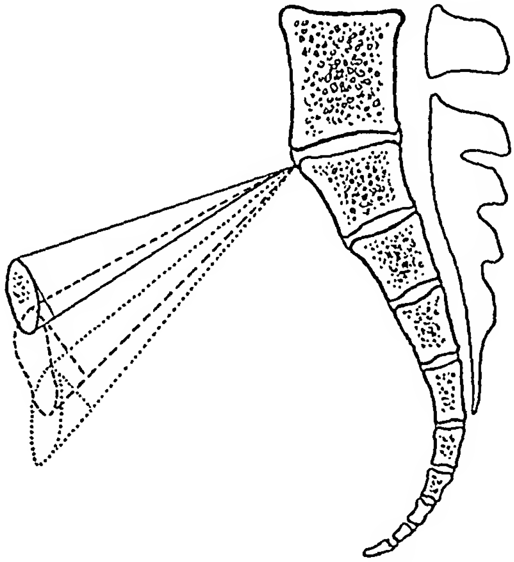


Fig. 351.—Diagram indicating the variation in the deduction from the diagonal conjugate to obtain the true conjugate caused by differences in thickness, height, and position of the symphysis. (Stoeckel.)

This steadies the hand and allows the elbow to be depressed sufficiently for efficient investigation. The first and second fingers are introduced into the

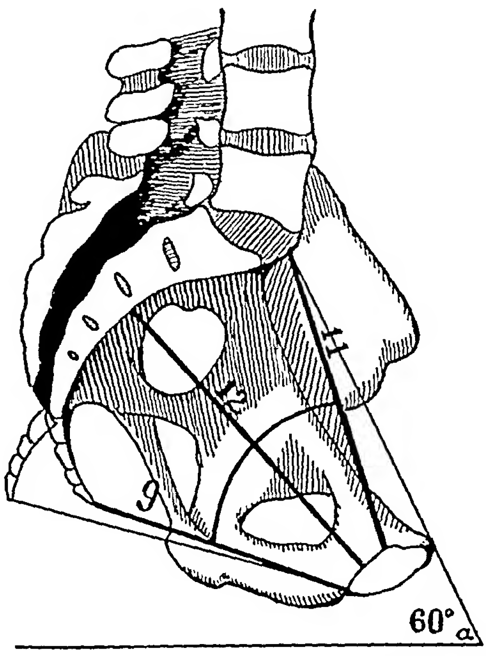


Fig. 352.—Sagittal section through the normal pelvis showing the anteroposterior diameters, the axis of the pelvis and the pelvic inclination. (Redrawn from Bumm.)

vagina and carried gently upward. The perineum in a woman whose pelvis is normal must be pushed in somewhat by the knuckles of the remaining fingers.

to measure the anterior and posterior sagittal diameters of the outlet. DeLee's outlet pelvimeter, a modification of that of Ayres, is also useful. The bi-

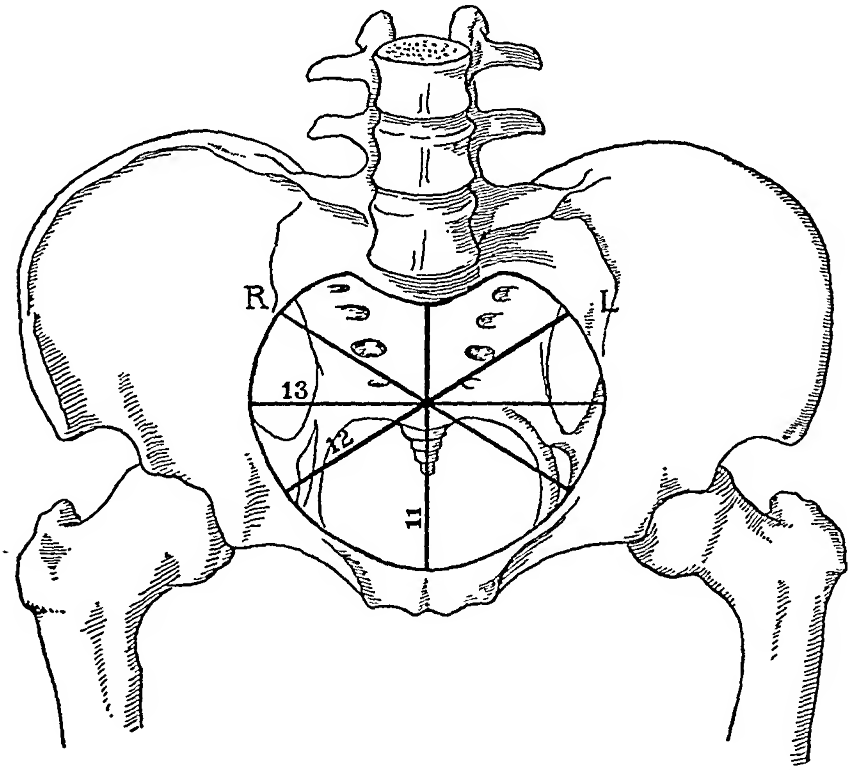


Fig. 353.—Pelvis seen from above, showing diameters of inlet. (Redrawn from Bumm.)

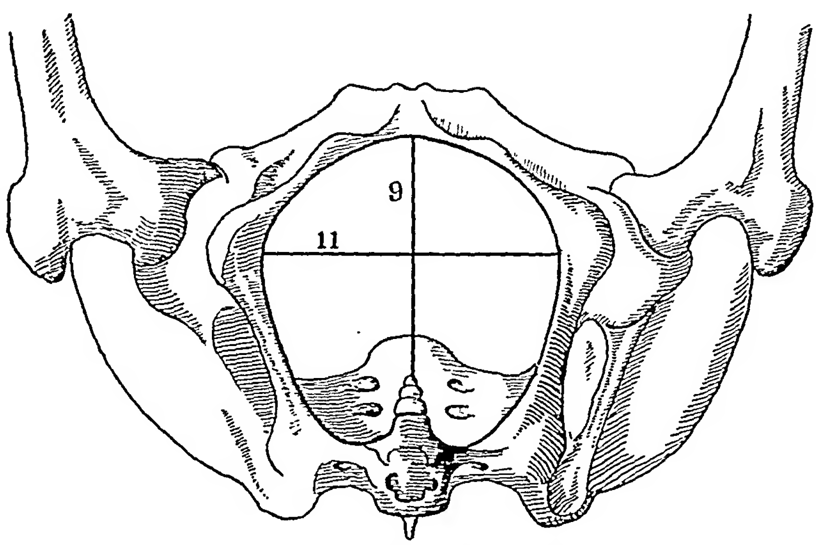


Fig. 354.—Pelvis seen from below, showing diameters of outlet. (Redrawn from Bumm.)

ischial diameter in a normal pelvis is 11 cm. This diameter normally is 9.5 cm. on the scale of the instrument. To this should usually be added 1 to 1.5 cm. to allow for the soft tissues under the instrument. As Neu re-

asepsis. Vaginal discharge is increased in so many pregnant women that leukocytes may be found in the urine of nearly all of them. The catheterized specimen ensures that any leukocytes found in it come from the urinary tract.

Blood pressure taking is an essential part of the routine pregnancy visit. So far as toxemia is concerned the taking of the blood pressure is the most important single observation. A suspicious rise in blood pressure is often obtained before any other symptom is noted, very often before any change is noted in the urine.

It is apparent that at least in a considerable proportion of pregnant women a moderate hypotension is found. In 1918 a study was made by the writer[11] upon a series of 447 pregnant women to determine the average blood pressure. In 115 private patients who formed a part of this series and upon whom 608 observations were made the average pressure was 114. In the other women in this series, 245 who entered the hospital with no evidence of toxemia gave an average pressure of 119. Haussling, who made 682 observations on 140 patients, reported an average pressure of 113. Lynch, Newell, and Wallich and Judd have also reported series of observations. It is universally agreed that toxemia is accompanied by an increase of blood pressure in all but very exceptional cases. Rarely eclampsia may occur without a previous rise in pressure or with a rise which is much less than usual. The fact that many pregnant women have a pressure a little lower than normal makes the increase of pressure rather more significant. A failure to observe blood pressure systematically during pregnancy may fairly be regarded as neglect. A rise to 140 or more calls for careful watching and increase in the frequency of observation. The more rapid the rise of pressure the greater the need for vigilance. Occasionally a woman is seen who carries a tension above normal throughout the pregnancy—the so-called "essential hypertension." Whether these may be in fact mere individual peculiarities and based upon no underlying abnormality or whether they may be an expression of some latent and unrecognized pathology does not influence the clinical fact that these women usually pass through pregnancy well. A consistently elevated pressure is far less ominous than an elevation of pressure in a woman whose previous pressure has been normal. None the less, the woman with a pressure constantly over normal requires careful supervision.

Diet during Pregnancy.—The dietary habits, provided these are normal, will require but little alteration. The pregnant woman should be warned against the two frequent forms of advice which so constantly emanate from the self-constituted obstetrical authorities of which every neighborhood possesses its quota. These are, first, that she should eat largely because she is eating for two, and, second, she should eat sparingly because if she does not her baby will be too large. She should be assured that neither of these dicta has any value. As to the first, one may assure her that if her own appetite is satisfied the baby will obtain all that is needed, indeed, that the infant's necessities come before those of the mother, as is the biological rule in all animate creation. Concerning the second statement, she may be told that it is quite impossible to influence the weight of the unborn child except within very narrow limits. Prochownik's diet, which was suggested a generation ago for the purpose of producing a small child in cases of contracted pelvis, has long since been given up. It not only failed to cause any notable diminution in the size of babies but the lessening of food intake was so drastic

nancy should be less than the usual 20 or 25 pounds. If she is markedly under the average for her height and age, or if she has recently lost weight, the gain which may be allowed may be increased. A table of weights, heights, and ages is of use in determining these points.

WEIGHT AND HEIGHT FOR WOMEN AT DIFFERENT AGES

Height.	19	20	21–22	23–24	25–29	30–34	35–39	40–44	45–49	50–54
4 ft. 10 in.	98	102	106	110	113	116	119	123	126	129
11 in.	103	107	109	112	115	118	121	125	128	131
5 ft.	109	112	113	115	117	120	123	127	130	133
1 in.	113	115	116	118	119	122	125	129	132	135
2 in.	116	118	119	120	121	124	127	132	135	138
3 in.	120	121	122	123	124	127	130	135	138	141
4 in.	123	124	125	126	128	131	134	138	141	144
5 in.	126	127	128	129	131	134	138	142	145	148
6 in.	129	130	131	133	135	138	142	146	149	152
7 in.	131	133	135	137	139	142	146	150	153	156
8 in.	135	137	139	141	143	146	150	154	157	161
9 in.	138	140	142	145	147	150	154	158	161	165
10 in.	141	143	145	148	151	154	157	161	164	169
11 in.	145	147	149	151	154	157	160	164	168	173
6 ft.	150	152	154	156	158	161	163	167	171	176

From "Food Nutrition and Health" by McCollum and Simmonds
Table prepared by Dr. Thomas D. Wood, Professor of Physical Education, Columbia University

Should the woman find it difficult to control her food intake sufficiently to avoid a too great increase in weight it is often of use to provide her with a simple calorie list, containing a sufficiently generous selection of foods, together with the calorie content of an average helping of each one. This is not entirely accurate but is sufficiently so for the purpose it is intended to accomplish. She should be asked to take a definite amount of food, usually about 1800 calories. This amount may be decreased or increased as later weights may demand. Many women get on comfortably on that amount or less. It is not uncommon for a woman whose food consumption has been too large to say that she is more comfortable on the reduced amount. One should be careful to maintain a balanced ration even though the total amount of food taken be reduced. About 15 per cent of the total should be protein, 25 per cent fat, and 60 per cent carbohydrates. The overweight woman should not be permitted to reduce during pregnancy. It is sufficient that her weight be held at the same point or that it be permitted to increase slightly.

The practice of many women, particularly those who are overweight, is to eliminate entirely from their dietary certain articles which they believe to be particularly apt to cause them to gain in weight. This should not be permitted. A balanced ration is the normal one for the human organism and it should be continued during pregnancy. The amount, however, may need control. Much patience and diplomacy may be needed in managing the matter of weight, as some women dislike the slight trouble which the use of a calorie list entails and they sometimes do not want to give up certain things of which they are fond. It may be well to remember that a very acceptable salad dressing or mayonnaise may be made with mineral oil.

Dancing may be permitted if indulged in moderately. The pregnant woman should be advised that dancing parties lasting till the early morning hours are harmful.

Physicians who practice in large cities have many patients who live in apartment buildings not equipped with elevators. Should a pregnant woman live in an upper apartment she should be cautioned to make her trips up and down the stairs as few as possible.

As the end of pregnancy approaches the amount of exercise may have to be lessened. At no time should the pregnant woman be urged to take any form of exercise which causes great discomfort. At no time should she become greatly fatigued.

Discomforts Due to Weight and Pressure of the Pregnant Uterus.—Many pregnant women complain of discomforts which are caused by the presence of a bulky and heavy mass in the abdomen. Among these hemorrhoids are frequent. Return circulation from the lower part of the body is impeded and the hemorrhoidal veins become dilated. Should the discomfort or pain become severe, or should free bleeding or strangulation of the hemorrhoids occur, surgical removal of the hemorrhoids may be necessitated. This, however, is not frequent, as palliative remedies usually make it possible for the woman to pass through pregnancy without surgical interference. It is usually not possible to achieve a cure of the hemorrhoids during the pregnancy as the chief cause of their presence remains. Regularity in bowel evacuation removes the obstruction caused by fecal masses in the lower bowel and lessens the amount of straining effort. The means of attaining this is suggested elsewhere in this chapter. Hot fomentations or cold applications sometimes help when much swelling is present. Should large thrombi occur, much relief is sometimes obtained by opening the hemorrhoid under local anesthesia and turning out the clot. In a limited number of selected cases the writer has seen women made much more comfortable by local treatment, usually by injection, carried out by a skilful proctologist.

Varicose veins of the legs are frequently seen and are most troublesome in women who have had more than one pregnancy. They vary from small localized dilatations to large bulging varices extending from the ankle up into the thigh. No radical treatment is to be thought of during pregnancy. Some relief may be had by the recumbent position. The benefit of this is enhanced if the lower extremities are elevated. A marked degree of elevation is better than a little.

The old-fashioned woven rubber and fabric bandage was hot and in addition was difficult to cleanse. A much better bandage for this purpose is the elastic woven "Tetra" bandage containing no rubber. This should be applied spirally from the ankle upward as a soldier puts on a puttee.

Another device which is sometimes of use when the varices are large is the use of small strips of adhesive plaster about 4 inches long and ½ inch wide placed across the dilated veins at distances of about 4 inches from each other. These serve to break up the column of blood and to reduce the pressure against the walls of the veins. Surgical treatment and injection of the dilated veins should be considered very carefully before active treatment is adopted. DeTakáts[15] expresses himself as follows: "The treatment of varicose veins during pregnancy has been under discussion in recent years. A distinction must be made between women who have had varicose veins before pregnancy

33. Seligmann: Zur Ätiologie der endogenen Puerperalinfektion, Inaug. Diss. Zt. f. Geb. u. Gyn., lxxv.
34. Sigwart: Demonstrationen von Blutagarplatten mit hämolytischen streptocokken, Ges. f. Geb. u. Gyn. zu Berlin, Zentralbl. f. Gyn., 1909, S. 153.
35. Slemons, J. M.: Involution of the Uterus and Its Effect Upon the Nitrogen Output of the Urine, Johns Hopkins Hosp. Bull., Baltimore, 1914–1921, 195, 200.
36. Sundin: Hygiea, 1909, rev. in Gyn. Rundschau, iv, 500.
37. Traugott und Goldstrom: Ueber die bacteriologische untersuchung des Vaginalsekrets Kreisender für den Verlauf des Wochenbetts, Zentralbl. f. Gyn., 1913, No. 17.
38. White, Charles, F. R. S.: Treatise on the Management of Pregnant and Lying-in Women, London, 1773.
39. Williams, J. Whitridge: Obstetrics, 6th ed.
40. Wormser, E.: Die Regeneration der Uterusschleimhaut nach der Geburt, Arch. f. Gyn., 1903, lxix, p. 449.

Bland, First, and Goldstein[6] studied the blood platelets in pregnancy and the puerperium. Counts were made on 230 pregnant women. Of these 77 per cent had 200,000 to 350,000 platelets per c.mm. and 18.2 per cent had over 350,000 per c.mm. No noteworthy relation between the number of platelets and the length of pregnancy could be determined. Comparison of platelet counts in pregnant and nonpregnant women convinced these investigators that no notable change in the number of platelets occurs during pregnancy, although Bizzozero believed that an increase took place. Apparently an increase in the number of platelets is not essential for the increase of coagulability, as this function is cared for by the increase in fibrinogen. A low platelet count associated with a marked anemia may be an expression of a hemorrhagic diathesis. In such cases it may be of value to stimulate platelet formation by the ultraviolet light.

Bruchsaler[7] studied the fibrinogen content of the blood in pregnant women. He found that in the later months of pregnancy and during and shortly after delivery the fibrinogen content of the blood is increased. This occurred together with an acceleration in sedimentation rate. Apparently fibrinogen plays an important part in determining the sedimentation reaction. The increase in fibrinogen may be a part of a defensive mechanism against bleeding.

Goncalves d'Azeredo[22] studied the sedimentation rate in 97 women in the fifth month of pregnancy. Only 2 of them showed a retarded rate. The remaining 95 showed a marked acceleration in the sedimentation time. His experience agrees with the experience of Vignes and Levy-Solal. Bland, Goldstein, and First studied the sedimentation time in 540 women in different periods of pregnancy. In 536 of these the rate was accelerated. In 453 women examined in the sixth month or later, 75 per cent showed a marked acceleration of sedimentation time. Women having a leukocyte count of 15,000 or more during pregnancy gave a very rapid sedimentation time.

We may, therefore, assume that in the majority of pregnant women a definite reduction in sedimentation time is to be expected.

Clothing.—Fortunately, the entire scheme of feminine attire is upon a more rational basis than during the Victorian era and earlier. The majority of young women who become prospective mothers today have come to maturity under more favorable conditions, so far as dress is concerned, than women of previous generations. Not only the less confining character of present-day dress has been of value in permitting a better muscular development, but the lighter and more open garments worn at present permit of better ventilation. The greater exposure to sunlight has contributed to bodily vigor and has lessened anemia. Anemic and chlorotic girls are less frequently seen than was the case twenty-five years ago. Osler quotes Rosenbach thus: "The corset and chlorosis." He emphasizes too that it was less frequent in country-bred girls. Many young women today have not worn corsets and the less bulky costumes of recent years have been greatly to their physical advantage.

The pregnant woman who dresses sensibly does not need to make many alterations in her dress. Her clothing should be seasonable, that is, it should afford sufficient protection against cold in winter and should not be oppressive in the hot seasons. Even in winter too much and too heavy indoor clothing should not be worn, the extra protection necessitated against the low outdoor temperature being provided by outer garments.

out its dental attendant. The presence of oral infection even in patients of the better class is a real and not an imaginary thing.

In a series of 242 private patients studied by Galloway[21] and upon whom full mouth dental films were taken, 36, or 15 per cent, were found to have apical root abscesses. Too little attention is given to this important phase of prenatal care. Oral hygiene is still neglected even in some excellent clinics and in the hands of some able obstetricians.

All cavities should be attended to at once. Any necessary cleaning of the teeth should be carried out. In addition to routine dental work it is important that any infections should be detected. If necessary x-ray films of the tooth roots should be taken. Devitalized teeth particularly require attention. Should root abscesses be found they should be cared for at once. Extraction of teeth, about the roots of which abscesses are found, should be done if needed. The danger of abortion following extraction is exceedingly small. In many scores of cases in which extractions have been done the writer has not seen it occur. Extractions should, if possible, be done by a dentist who has developed skill in this work. Local anesthesia is preferable as the extraction can be done more slowly and with less trauma.

The elimination of infections is of importance for several reasons: (1) Women who are carriers of focal infections are somewhat more likely to develop toxemia. (2) The elimination of foci of infection lessens the likelihood of pyelitis of pregnancy. Urologists seem quite convinced of the part played by infective foci in the production of infections of the urinary tract. (3) Abortion may be caused by hemogenic infection of the placenta caused by bacteria originating from an infective focus. Curtis[10] has drawn attention to the relationship between focal infection and abortion and the writer has seen one case of abortion in which a recent infected infarct was found in the placenta and, in addition, two women who had aborted repeatedly and who had extensive oral sepsis. Both of these, after their mouths were put in healthy condition, went through later pregnancy successfully. Nickel and Mussey[53] were able to produce abortion in pregnant guinea-pigs by the intravenous injection of streptococci isolated from foci of infection found in women who had aborted. Their work seemed to indicate a specific localization in the uterus when bacteria were obtained from women who had aborted. This localization was not noted in similar experiments done with bacteria taken from foci in women who had not aborted. (4) Phlebitis is less likely if no foci are present. Every obstetrician has seen cases in which normal spontaneous delivery occurred and in which phlebitis followed. One cannot fail to be struck with the frequency with which foci of infection are found to be present in these cases.

The securing of a completely healthy oral condition definitely increases the probability of a normal pregnancy and puerperium.

If upon the first inspection the teeth are found to be in satisfactory condition, or after any necessary dental work has been done, it is well to have the dentist inspect them again at intervals of about two months. Defects which may appear are thus promptly discovered.

By dietary precautions dental decay may be limited. Evidence has accumulated of late which has caused dentists to conclude that vitamin deficiencies in the diet are at least partially responsible for dental caries. The vitamins particularly concerned are D and C. The diet of most persons

Many women complain of a sense of fulness and even discomfort very early in pregnancy and this may continue in greater or less degree throughout the pregnancy. It is merely the result of physiologic engorgement and need cause no anxiety.

It is often necessary for the physician to keep the pregnant woman from doing unnecessary and harmful things to her breasts. There is a widely spread impression among the public that the skin of the nipples may be made tougher, thicker, or more resistant by the application of "hardening lotions." Experience has abundantly demonstrated that these are useless and at times harmful. The character of the skin which an individual possesses cannot be changed but it is possible to keep it in the most healthy condition. Young women are often advised by older women to rub the nipples briskly with a rough cloth or even to scrub them with a brush. These practices, particularly the latter, are painful, useless, and harmful. They do not toughen the skin and they are apt to cause scratches or abrasions.

The use of mineral oil, vaselin, or lanolin to render the skin of the nipple pliable is often suggested. This is much less objectionable than any of the methods noted above but is of little value. It would seem logical that, as we wish to keep the skin of the nipple in as healthy a condition as possible, it would be better to refrain from the use of oily or greasy substances which would be rather likely to close up the mouths of the glands of the skin.

The most useful and withal most logical procedure is the simplest one. The woman is advised, as soon as the presence of secretion in the breast is noted, to wash the nipples gently once a day with a bland nonirritating soap and to dry them with a *soft cloth gently*. Gentleness of manipulation should be stressed. If secretion is not noted this should be done in the last three months in any event.

A few women complain of profuse secretion from the breasts during pregnancy. This is not abnormal or harmful and requires no treatment. Pads of clean gauze may be worn under the brassiere to absorb the secretion. No absolute prophylaxis of breast infection exists but it is wise to put the breasts in as healthy and normal a condition as possible.

Should the nipples be flat the woman may be instructed to pull them out gently with the fingers. In extreme cases of inversion this is of little avail but in the lesser degrees it sometimes helps. An actively nursing baby will occasionally bring out a nipple which could not be developed during pregnancy. Mechanical devices are of little use. The plastic surgical procedures which have been described for the correction of inverted nipples are not recommended.

The Thyroid in Pregnancy.—Thyroid abnormality may be noted in the first examination. If none is present the physician should be on the lookout for evidences of thyroid trouble as the pregnancy proceeds. Should any deviation from the normal be observed a basal metabolic rate should be taken.

Hypothyroidism is managed, as in nonpregnant patients, by the administration of thyroid. It is best in pregnant women to begin with small doses as these can be increased if found inadequate. Careful observation is of course requisite after the institution of thyroid therapy.

Adenomatous goiter, if no hyperthyroidism is present, does not need treatment during pregnancy unless the tumor mass produces mechanical

management of the more severe cases should reduce the necessity for abortion to a very low level.

Nausea.—Severe and intractable vomiting, or early toxemia of pregnancy, will be dealt with in the section devoted to complications of pregnancy. In the course of normal pregnancy, however, many women are seen who are troubled by nausea to a degree which calls for relief.

About one half of all pregnant women are troubled by nausea which may vary from a mere sensation of nausea to severe vomiting. It is often felt in the morning, hence the name "morning sickness," but this is not invariably so.

While all nausea is probably due, at least partially, to a toxemia which in its severe degrees becomes troublesome or even dangerous, there is a definite nervous factor which must be recognized.

A few suggestions to the pregnant woman may be of distinct value in aiding her to control the nausea. If nausea is at all troublesome the pregnant woman should give up the preparation of food, which nearly always aggravates the feeling of nausea. It is very difficult, if not impossible, to control nausea if the woman is exposed to the odors of cooking and constant sight of food.

If nausea is not severe and the woman is in ordinary health she should be counselled to make every effort to control vomiting, as a vomiting habit is easily contracted and is difficult to abolish. It is well to tell her frankly that it is not possible to cause all feeling of nausea to disappear, that this must be endured for a time, and that it must not be allowed to interfere with the normal taking of food. A woman of ordinary intelligence who is not of a neurotic type will nearly always cooperate. She may be assured that in the great majority of cases the nausea will disappear by the end of the third month. It may help considerably if breakfast be taken in bed, where the woman should remain for about an hour afterward.

It often helps if small amounts of food are taken at frequent intervals, as six times daily instead of three. The amount of food taken in six feedings should be the same as is consumed in the usual three meals. The dry foods are better than liquids, the latter being more easily rejected. One may suggest toasted bread or crackers, with or without butter, vegetables, preferably cooked, stewed fruits, and cereals to which has been added a small amount of cream and as much sugar as desired. Carbohydrates in the form of candy seem to help in some cases.

Drugs are of little value. It is probable that the effect of all of them is partially, if not largely, suggestive. Bromides, cerium oxalate, corpus luteum intramuscularly or by mouth, have been suggested. If corpus luteum is used it is best to give it intramuscularly, both for any possible physiologic effect which it may have, and because its suggestive value is increased by this mode of administration. For some reason a semiproprietary digestant known as "ingluvin" helps in some cases. This may also be suggestive. If the nausea is not relieved by these simple means the more elaborate forms of management which are required for early toxemia may be needed. These are considered in another chapter.

Care of Bowels.—Regular bowel activity should be maintained. An evacuation should occur once a day. Every effort should be made to secure this result by dietary regulation. The use of cathartics and enemas should be

Alkaline solutions are often suggested but it seems more logical, inasmuch as the normal vaginal secretion is mildly acid, to use a weakly acid solution. Lactic acid, 2 teaspoonfuls in 2 quarts of warm water, is very satisfactory. Patients should be advised to use as few douches as possible.

Bathing.—During pregnancy the skin is rather more active than at other times and bathing is therefore important. Warm baths may be taken freely. Extremes of temperature, both heat and cold, should be avoided because of their possible effect in stimulating the uterus to contract and thus increasing the likelihood of abortion. It is conceded that this risk is small but the possibility of this accident should not be overlooked.

Turkish and Russian baths are to be avoided for the same reason. Warm showers are quite harmless and may be freely taken.

During the latter part of pregnancy, certainly during the last two weeks, tub baths should be given up. There is a real danger, particularly in multigravidae in whom the vaginal outlet is relaxed, that the bath water may enter the vagina. As tub water is far from sterile this is to be guarded against. Showers may be used until the end of pregnancy, however, and even after the onset of labor.

Sexual Intercourse during Pregnancy.—This may continue in moderation up to the seventh month. From the seventh month on it is advisable that it should be given up. During the ninth month it must positively cease. The danger of infection following invasion of the birth canal in any way is too great. Many instances have been reported of puerperal sepsis in women who had intercourse just before the onset of labor.

Excesses must be avoided at all times and the feelings and inclinations of the woman should be respected. Women vary in this regard widely; in some a strong aversion is felt while in others desire may be greatly increased.

Where repeated abortion has occurred it is wiser that marital relations be given up. The same holds true where a tendency to premature labor exists. As abortion is most frequent during the first three months, during which time 80 per cent of abortions occur, particular care should be observed at this time.

Determination of Sex.—The accoucheur is often asked to tell the sex of the infant. It is best to answer frankly at once that this is impossible. Up to this time no method of determination of sex has appeared. It is equally impossible to influence the sex of the expected child. The sex is determined at the time the egg is fertilized, or, as some authorities believe, certain eggs can produce only females and others males. Keibel and Mall[24] believe that nothing will influence the determination of sex. If the sex of the embryo is determined at this early date, the complete futility of the many devices which are suggested by nonmedical persons for the purpose of producing a boy or girl as may be desired, most of these depending upon some maneuver practiced after pregnancy has started, becomes apparent.

Many methods of predicting the sex of the unborn child are suggested by relatives and friends of patients, often with the statement that the plan suggested has worked in a series of two or three trials. As there are but two sexes it is evident that almost any method might chance to be right in the majority of a small number. Trials in large series indicate that we are unable to predict sex. Frankenhauser's method of counting heart tones at term,

confidence. The mental make-up of the parent, weak or otherwise, may descend to the child, but inheritance is not influenced by passing activities. As a distinguished biologist put it "wooden heads are inherited but wooden legs are not."

The fear of "maternal impressions" is still met with. By this is meant physical or mental abnormalities of the child produced by mental shock or physical injury sustained by the mother. This belief that the unborn child may be so influenced has come down from the earliest days of written history and is said to prevail even among uncivilized races. Numerous references to it in nonmedical literature occur. Nearly all later teratological writers agree that no scientific evidence exists for such a belief.

When the pregnant woman expresses a fear that her child may be "marked" she may be told clearly and with entire confidence that no such occurrence is possible.

Briefly, the evidence against it may be summed up as follows:

1. No nervous communication between the mother and fetus has been demonstrated.

2. In many cases of physical abnormality of the fetus the abnormality must have been present before the event which is supposed to have caused it occurred.

3. Many women who deliver physically defective infants have had no disagreeable experience to which to charge the event. Conversely, many women have been known to pass through various harrowing experiences without any abnormality of the child resulting.

4. All of the physical abnormalities observed in human infants are seen in the young of lower animals. That these were caused by impressions produced upon the mind of the mother animal could scarcely be insisted upon.

Determination of Date of Labor.—The usual rule, suggested by Naegele, is to count nine months ahead from the first day of the last menstruation and add seven days, or, as is easier, to count back three months and add seven days. In about 60 per cent of cases this will be correct within eight days in either direction. When only one coitus has occurred one may count two hundred seventy-three days from this date, which is usually correct within seven days.

It must be recognized that pregnancy varies in length and no method can be wholly accurate. Further, in most cases neither the date of ovulation nor the date of the fruitful coitus can be known. It seems probable that in most women ovulation occurs about ten to fourteen days after the end of menstruation but one cannot be certain that this is so in every case. While the average length of gestation is two hundred eighty days Williams has noted that in many young women who miss the first period after marriage, a normally developed child is born two hundred eighty days from the beginning of the last menstrual period. This would indicate that pregnancy does not always last ten lunar months. The estimation of the date of delivery from a single coitus is open to inaccuracy for the following reasons:

1. The exact date of ovulation is not known.

2. It is not known how long the spermatazoon may be in the reproductive tract before fertilization of the ovum takes place.

3. The length of pregnancy itself is known to vary.

The estimation of the date of delivery from the date upon which fetal

1. The diagnosis of pregnancy by the demonstration upon the film of the fetal skeleton.
2. To confirm or disprove the presence of a suspected multiple pregnancy.
3. For diagnosis of certain fetal abnormalities—notably anencephalus and hydrocephalus.
4. For the demonstration of certain pelvic abnormalities which cannot be fully made out by measurements.
5. For the taking of pelvic measurements.
6. As an aid in the diagnosis of intra-uterine fetal death.
7. Occasionally to show progress during labor.
8. For diagnosis of the position of the fetus when this cannot adequately be done otherwise; for example, face and brow positions.
9. For the diagnosis of postmaturity.
10. For differentiation between pregnancy and pelvic tumor. For this purpose the roentgenogram may have a medicolegal value.

In making films, the purpose of which is to show the fetus, it is best to place the woman on her face, supporting the knees and chest with pillows. This brings the uterine contents nearer the roentgen tube and produces a clearer film. In making films for the study of cases the Potter-Bucky diaphragm is of great assistance.

Dangers.—A discussion of the effect of irradiation upon the ovary does not come within the scope of this chapter. We are concerned only with the use of x-ray for the purposes indicated in the list given above. These require the use of x-ray only in pregnancies, for the most part, far advanced. It is generally agreed that x-ray treatment should not be used over the abdomen in women in whom pregnancy is suspected. Gastro-intestinal diagnostic procedures are better deferred, and the treatment of uterine fibromyomata by x-ray, which is rarely indicated under any circumstances, should not be done at this time. Repeated exposures to x-rays should be avoided. Bailey and Bagg have clearly shown that too great exposure to x-ray during early pregnancy carries with it a definite risk of abortion or of injury to the embryo.

In later pregnancies, also, too great exposure may cause some interference with the orderly sequence of embryological development which may not be apparent at birth but which may lead to some developmental abnormality later. This may conceivably even take the form of endocrine disturbances due to damage sustained by the endocrine glands.

At any time the amount of exposure to the rays should be small. For any of the obstetrical purposes noted above only a brief exposure is needed.

Experience indicates that the amount of exposure which is necessary for obstetrical diagnosis in the later months of pregnancy may be given by a skilful roentgenologist without any clinical evidence of injury to infant or mother. The fact, however, that the x-ray has great possibilities for harm must not be lost sight of. (1) The x-ray during pregnancy is most useful during the later months. (2) Exposure should be as brief as possible. (3) Any necessary x-ray examination should be made by an experienced roentgenologist who will endeavor to limit the period of exposure.

Diagnosis of Pregnancy.—1. Early pregnancy may be recognized by the use of *pneumoperitoneum.* By this means it is possible to visualize the gestational alteration in the form as well as the size of the uterus. This method is of more value in differential diagnosis between early pregnancy and pelvic

columns. Error may arise through the superimposition of the shadows of the spinal columns or heads. In the knowledge of the writer this occurred in a case of triplets leading to a diagnosis of twins when three infants were in the uterus. A number of cases have been reported in which the presence of three fetuses has been determined by *x*-ray and in a recent case in Germany four infants were shown on the film.

3. *For Diagnosis of Fetal Abnormalities or Monsters.*—The commonest form of monster is the anencephalus, or congenital absence of the encephalon. Ballentyne found this abnormality to constitute 14 per cent of a series of 325 cases of monstrosity studied by him. The characteristic deformity is the absence of the cranial vault and its contained brain. In some cases, also, a lack of development of the laminae of the vertebral column is also present and may lead to a combined cranial and vertebral defect, or craniorachischisis.

Associated defects, such as clubfoot, may be present. In anencephaly the characteristic radiological finding is the absence of the calvarium. The bones of the base of the skull are easily seen but the cranial vault is missing. An exaggerated fissure in the cervical spine may sometimes be recognized. A coincident hydramnion is a frequent finding. Hydrocephalus is usually easily demonstrated by roentgenography. A knowledge of the presence of this fetal abnormality is of definite value to the obstetrician as it may influence his choice of the method of treatment. The great size of the calvarium, which is entirely disproportionate to that of the base of the skull, is pathognomonic. The globular form of these distended heads is also characteristic.

Absence of or shortening of the extremities (hemimelia) shows readily, as a rule. The alteration of length in the long bones which is characteristic of chondrodystrophia may also be recognized.

Fusion of the extremities (symmelia or sympodia) is usually recognized but when two feet are present an error may occur. The presence of but one foot in the film would be conclusive.

Many of the double monsters may be diagnosed by radiographical methods. Even in those in which the two fetuses are joined only by a narrow band of union, as the xiphopagus or the ischiopagus, the attachment may in many cases be shown on the film. Those monsters in which the double development is only partial are more easily recognized.

It is often of value to the obstetrician to know that a monster is present before the end of pregnancy. He may, when in possession of that information, be enabled to plan his obstetrical procedure to the best advantage of the mother. For example, in the presence of an anencephalus, one may wish to terminate the pregnancy before term rather than allow the mother to go to the full length of pregnancy when it is certain she will not have a living and normal child.

One would not do an abdominal delivery in the presence of a monster unless the monstrosity were of such a type that labor would subject the mother to too great risk.

For an exhaustive discussion of teratologic radiography the reader is referred to the monograph of Dorland and Hubeny.

4. *Demonstration of Pelvic Abnormalities Which Cannot Fully Be Made Out by Measurements.*—In moderately contracted pelvis the roentgenogram will give an outline of the superior strait and an idea of the size of the fetal head in comparison to the inlet, which is in some cases helpful. It may be

at the exact distance from the film as the pelvic inlet of the woman in the previous exposure. Another film is then taken. By placing these two films in the viewing box at the same time the pelvic diameters may be read off in centimeters. Chamberlin's method also requires no mathematics.

The methods of x-ray measurement of the pelvis will probably find a limited application. Recent methods make possible its use up to the end of pregnancy. This is the time when the need for its use may be greatest.

Fig. 357.—Brow presentation. (Michael Reese Hospital.)

6. *Diagnosis of Fetal Death.*—The use of x-ray as a confirmation of the usual signs of fetal death was proposed by Spaulding and later by Horner. Both of these writers called attention to the overriding of the cranial bones and suggested it as a sign of fetal death. There seems to be no doubt that this sign is observed in roentgenograms of dead fetuses but Stein and Arens and others have described the same condition in films made of pregnant women who later delivered living children. The x-ray film, therefore, can give presumptive, but not positive, evidence of fetal death.

trance of the needle into the amniotic cavity being recognized by the appearance of amniotic fluid through the needle. The opaque fluid is then introduced slowly, a little amniotic fluid being allowed to escape, and about a half hour is allowed to elapse in order that the opaque fluid may thoroughly diffuse in the amniotic fluid. The woman is asked to move about in order to favor this. These authors believe that clear shadows of the fetus are obtained due to a better contrast between it and the fluid in which it lies. They had no untoward results in their series of cases. Until more experience is available the method had best be restricted to experts in the field of radiology.

Final Examination.—At the beginning of the ninth month an examination should be made. It is not wise to allow the pregnancy to proceed to term with a malposition of the fetus or other obstetrical abnormality unrecognized. At this time the obstetrician makes the following observations:

1. The usual blood pressure observation and urine analysis.

2. Abdominal inspection and palpation. The height of the fundus (indicating the probable duration of pregnancy) is observed. The position and presentation of the child is noted. It is important that a breech or transverse position be recognized and that a posterior cephalic position should be detected. The woman should not be allowed to go into labor with an unrecognized abnormality of position.

3. Any peculiarities noted upon palpation which may suggest fetal abnormalities—as anencephalus or hydrocephalus—or the possible presence of a multiple pregnancy are important. These may call for the use of the *x*-ray. The presence of an hydramnion always causes one to suspect a fetal abnormality.

4. The fetal heart tones. Their location and whether they are normal in strength. One does not attempt to predict sex from the rate of the fetal heart.

5. Vaginal examination. This is done gently. One notes: (*a*) Whether the head is floating freely above the pelvic inlet or whether it has entered the pelvis, and if so, to what level.

(*b*) The size of the head, whether normal or larger or smaller than normal. Will this head probably come through this pelvis or not, allowing for the increase in size of the last month?

(*c*) The cervix, effaced or uneffaced, soft or firm. A cervix which earlier in pregnancy may have seemed quite rigid may be found soft and succulent at this time.

(*d*) Any vaginal abnormality. Inflammatory conditions and firm old scars which may interfere with ease of delivery are to be noted.

After this time vaginal examination should not be repeated. Should a pelvic examination be required during the ninth month it should be done rectally. Invasion of the birth canal for any reason during the ninth month should be rigidly restricted. It adds a very definite risk of infection. The sooner labor comes on after such an invasion the greater the risk.

AUTHOR'S SUGGESTIONS TO PREGNANT WOMEN

Introduction.—These notes were not written in order to avoid answering questions but that they might be answered better. Each individual presents a separate case which may require different questions which you should feel free to ask.

You should not gain in weight during pregnancy more than 20 pounds providing you are at your normal weight when pregnancy starts.

This is important, because:

1. Overweight women furnish most of the cases of toxemia which occurs usually late in pregnancy.

2. You will be more apt to nurse your baby if you keep your weight down.

Restriction of the amount of food taken and of your gain in weight has very little influence on the baby's weight. It is advised because experience has abundantly shown that too great an increase in the mother's weight increases her danger of toxemia. Women who are overweight at the beginning of pregnancy should be especially careful.

In the early weeks of pregnancy you may find it beneficial to eat oftener than usual, taking small amounts of food each time. This is especially true if you have a tendency to be nauseated. If nauseated take six small feedings a day. You may not feel like eating but you will feel better if you will force yourself to do so. Nausea of pregnancy becomes worse when one's stomach is empty.

If you are nauseated in the early morning place some milk in a thermos bottle and some crackers beside your bed when you retire. Eat these before you arise and then after fifteen or twenty minutes get up slowly. Avoid washing your teeth or mouth before breakfast.

Avoid fats, highly seasoned foods, and coarse indigestible salads. Limit the amount of meat to one average portion a day.

You may have coffee in the morning and tea in the afternoon or evening. Light wines are permitted in moderation.

Drink at least eight glasses of water daily.

If you are told to diet because of toxemia the following list of foods and these only are to be used. *Do not eat much, for starvation is beneficial in such a condition.*

The quantity of these various foods will be gone into with each individual case. *Many of the things mentioned are quite nourishing* but as you will notice do not contain much protein.

DIET FOR TOXEMIA

Cream soups except those containing chicken, beef, beans or peas.
Dairy products:
    Butter. Milk. Buttermilk.
Vegetable foods.
Cereals:
    Bran flakes. Oatmeal.
Breads:
    Graham and Whole Wheat.
Vegetables: Any vegetable except beans (lima, navy, and kidney), lentils, peas, and potatoes. Preferably green vegetables in season.
All Fruits, Berries and Melons.
All Canned Preserves and Jellies.
Puddings and Desserts:
    Tapioca. Jellos. Ices.
Sugars:
    White or Brown Hard Candy. Honey. Molasses.
In cooking use butter and bacon fat in place of lard whenever possible.
Avoid all spiced foods and those with much salt.
Drink at least 2 quarts of liquids daily.

Food.	Average serving.	Calories.
Cornflakes	½ cup	40
Cornmeal (cooked)	½ cup	75
Corn syrup	2 tbsp.	180
Crackers, graham	1	48
Crackers, white	2	35
Cranberry sauce	¼ cup	100
Cream 15%	1 tbsp.	40
Cream sauce	3 tbsp.	100
Cucumber	8 slices	8
Custard	⅓ cup	100
Dandelion greens	½ cup	63
Dates	4	95
Duck	1 large slice	75
Egg (whole)	1	78
Egg (white)	1	14
Egg (yolk)	1	64
Eggplant	½ cup	28
Endive	½ cup	15
Farina	½ cup	75
Figs (dried)	3	200
Figs (stewed)	½ cup	325
Fish—Cod (creamed)	½ cup	100
Halibut	3″ x 2″	75
Salmon (canned)	½ cup	100
Salmon (fresh)	3″ x 2″	80
Trout	3″ x 2″	80
Tuna	½ cup	100
Mackerel	3″ x 2″	100
French dressing	1 tbsp.	66
Fudge	1″ cube	100
Gelatin	2 tbsp.	18
Gingerale	1 glass	58
Gingerbread	1″ x 4″ x 2″	275
Grapefruit (fresh)	½	100
Grapejuice	½ cup	100
Grapenuts	3 tbsp.	100
Grapes	24	99
Gravy	1 tbsp.	25
Griddlecakes (without butter or syrup)	1 4″	100
Ham (fresh—lean)	1 slice	118
Heart, beef	1 slice	125
Hominy (boiled)	½ cup	365
Honey	1 tbsp.	67
Ice cream	½ cup	200
Ice cream soda	1	300
Ice cream sundae	1	300
Jelly	1 tbsp.	80
Jello	1 cup	66
Kohlrabi	½ cup	31
Koumiss	1 glass	70
Lamb chop	1	96
Lamb roast	1 slice	200
Lamb stew	1 cup	200
Lemon juice	1 tbsp.	5
Lettuce (small leaves)	4	5
Liver, calves	2 slices	133
Lobster	½ cup	40
Macaroni (cooked)	½ cup	125
Malted milk (prepared)	1 glass	590
Malted milk (powder)	1 tbsp.	40

Food.	Average serving.	Calories.
Raisins	¼ cup	100
Raspberries (fresh)	½ cup	50
Rhubarb (stewed)	½ cup	100
Rice, brown	6 tbsp.	180
Rice, white (boiled)	6 tbsp.	300
Rutabaga (mashed)	½ cup	42
Salsify, cooked	½ cup	42
Sardines	10	269
Sauerkraut	3 tbsp.	28
Sausages	1 small	50
Sherbet	½ cup	200
Shredded wheat	1	125
Soups:		
Beef broth	1 cup	39
Cream of tomato	1 cup	200
Vegetable	1 cup	100
Spaghetti (cooked)	¾ cup	366
Spinach	½ cup	16
Squash	½ cup	47
Strawberries	½ cup	30
Succotash	½ cup	75
Sugar	1 tsp.	26
Sweetbreads	1 portion	88
Tomato (cooked)	½ cup	20
Tomato (raw)	1	20
Turnips	½ cup	41
Veal chop	1	126
Veal roast	1 slice	100
Waffle	1 6″	200
Watermelon	1 slice	20
Zwieback	1 slice	97

Your diet should consist of approximately 15 per cent protein, 25 per cent fat, and 60 per cent carbohydrates.

The greater part of the protein which we are in the habit of eating comes from meat, fowl, fish, eggs, cheese, and milk.

The greater part of the fat which we are in the habit of eating comes from butter, cream, bacon, meats, and oils, such as are used in salad dressings.

If you are using the caloric list it must be done regularly, the calories being counted every meal and every day.

Heart Burn.—Very frequently during pregnancy one has a burning or smarting either in the pit of the stomach, the chest, or the throat. There may be some other abdominal distress at the same time, such as fulness.

Sodium bicarbonate (soda) in doses of ½ to 1 teaspoonful in half a glass of water generally relieves it. This may be repeated several times daily.

Heart burn can many times be relieved by drinking larger amounts of water.

The Care of the Bowel.—You should have a bowel movement at least once every day. The frequency of the movements and the quantity are not the most essential factors, however. It is the consistency of the stool that one should watch. It should be essentially that of butter. Many people have a daily stool who are severely constipated and many people think they are normal because they are having a movement several times a day who are suffering from an inflammation of the bowel. Do not use enemas or cathartics if you can avoid them. Attempt to secure a movement by diet. If not

the column of blood. The best treatment is to lie down frequently and elevate the feet. Avoid standing for long periods.

Breasts.—Be careful to avoid any pressure on the breasts.

You do not need to apply any medication to the breasts for the purpose of "hardening" or "softening" them. Such things are of no value. Keep the nipples free from crusts with soap and water.

If your nipples are flat or inverted take them between your fingers and gently draw them out each day for a period of five or ten minutes.

If the breasts become quite large and heavy, they should be supported from the shoulders with a suitable brassiere. Avoid brassieres that have a tendency to press the breast against the chest wall instead of lifting it up.

Travel.—You should not travel.

Driving or riding by automobile moderate distances over city streets is permissible. You should not tour regardless of the road or other conditions.

Sexual Relations.—Sexual intercourse may be permitted the first seven months of pregnancy and after the baby is six weeks old providing there is no vaginal discharge. If there is any reason why it should not be indulged in you will be told.

Examinations.—Unless others are indicated there will be two internal examinations made, one at the time of your first visit and one at the beginning of the ninth month.

A general physical examination will be made at your first visit and at any other time it appears necessary.

Report every three weeks during the first six months, every two weeks during the seventh and eighth months, and every week from then until delivery.

Bring a 4-ounce specimen of urine with you each visit. It need not be a morning specimen but should be passed the same day it is brought. *It should be labeled with your name.*

If you are asked for a twenty-four-hour specimen, discard the first urine voided in the morning. Add a teaspoonful of boric acid to the bottle. Save all that is passed from then until the same hour the following day. At that time void and add the urine obtained to the collection. Measure it. Shake it well and bring 4 ounces of the same. Record the total amount on the label.

Report the Following at Once.—Bleeding.

Rupture of the bag of waters. This is indicated by a sudden uncontrollable gush of fluid of considerable quantity.

Marked reduction in the amount of urine passed.

Continuous headaches.

Recurring pelvic or abdominal cramps regardless of the duration of pregnancy.

Labor Signs.—Cramplike pains in the abdomen or back at or about the expected date of confinement, and occurring at regular intervals, *e. g.*, every twenty minutes or, perhaps, every five minutes, may be regarded as labor.

The bag of waters may rupture before labor begins.

If it is not your first baby and the bag of waters ruptures before the onset of labor you should go to the hospital at once.

In any case, go to the hospital when the pains come at intervals of ten or twelve minutes. If pains begin at shorter intervals, go at once.

Remember that premature labor is possible.

A knitted sacque, bootees, 2 wrapping blankets, cap, mittens, apron, rubber sheet, 2 quilted pads.

Care of the Baby.—If the baby requires any special attention for feeding or if any other irregularity exists you will be referred to a pediatrician.

It is advisable that you place your baby in the care of a pediatrician regardless of its condition.

1200 CALORIE DIET

Breakfast	*Noon*	*Dinner*
Orange or ½ grapefruit.	Tomato salad with mineral oil dressing.	Clear broth.
Poached or soft-boiled egg.	Three heaping tablespoonfuls of cauliflower.	Lamb chop (fat removed).
One slice toast with ½ square butter.	One glass milk.	Three heaping tablespoonfuls of spinach.
Black coffee.	One-half square of butter.	Three heaping tablespoonfuls of carrots.
	Tea or coffee.	One and one-half squares of butter.
	One stewed peach (without sugar).	Black tea or coffee.
		Fresh fruit—grapes.

1500 CALORIE DIET

Breakfast	*Noon*	*Dinner*
One-half grapefruit.	Asparagus tips on toast.	Clear broth.
One and one-half strips of bacon.	One and one-half squares of butter.	Medium lean steak.
One slice of toast with ½ square of butter.	One glass of whole milk.	Three tablespoonfuls of green peas.
Black coffee.	Lettuce salad with mineral oil dressing.	Three tablespoonfuls of mashed turnips.
	One serving of cantaloupe or fresh fruit.	One and one-half squares of butter.
	Tea or coffee.	One slice of bread.
		One glass of skim milk.
		Three tablespoonfuls of applesauce.
		Tea or coffee if desired.

1800 CALORIE DIET

Breakfast	*Noon*	*Dinner*
Orange.	Three tablespoonfuls of escalloped corn.	Clear broth.
One egg or 2 strips bacon.	Three tablespoonfuls of baked squash (Hubbard).	One serving of chopped steak.
One-half slice toast with ½ square of butter.	Tomato and lettuce salad with mineral oil dressing.	Three tablespoonfuls of brussel sprouts.
Cereal—small serving with whole milk—1 teaspoonful of sugar.	One glass of skim milk.	Three tablespoonfuls of beets.
	One slice of pineapple.	Pear salad with mineral oil dressing.
	One square of butter.	One slice of bread.
	One slice of bread.	One square of butter.
	Tea or coffee.	Three tablespoonfuls of blanc mange.
		Tea or coffee if desired.

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PYELITIS OF PREGNANCY

The first description of pyelitis of pregnancy appears to have been given by Smellie in his "Midwifery" which was published in 1752.

In 1892 Reblaub[12] published a report of several cases and discussed the management of the disease. Since that time an enormous literature has accumulated upon the subject. In 1916, when the author[3] published a paper upon "Pyelitis of Pregnancy," it was possible to collect 109 articles devoted to this subject. This list probably failed to include some papers which had appeared. Since that date there have been many additional contributions.

Causes.—It is highly probable that many cases of pyelitis in pregnancy are exacerbations of previously existing infections which have not been sufficiently severe to cause trouble. Twelve years ago, in the author's service, observations were made upon the urine of infants in the first week of extra-uterine life to ascertain the possible presence of pus. In a considerable number of these, pus cells were discovered. Pugh[11] states that the majority of his patients who suffered from pyelitis of pregnancy gave a history of pyelitis in infancy. Goeppert[7] and Kermauner believe that the pyelitis of pregnant women is probably a recurrence of a kidney infection of early life. It is apparently true that bacteria may pass through the kidney parenchyma without damage to it provided ureteral drainage is normally free. If drainage from the kidney is obstructed, infection of the pelvis of the kidney is prone to occur.

The pathway by which bacteria reach the kidney pelvis has been a matter of controversy. The two modes of entry which have appealed to the majority of writers have been: (1) Ascending infection along the ureteral lumen and (2) infection by way of the blood stream. The first theory appealed to many and the fact that an insufficiency of the ureterovesical valve is found in the latter months of pregnancy (Gauss,[6] Stoeckel,[14] Luchs[10]) lent attractiveness to this explanation. The fact which Curtis[2] pointed out that a notable retention of residual urine is found in late pregnancy and the observation by the author[3] that in the ninth month of pregnancy bacteria could be

If notable distention of the kidney occurs, it may be distinguished by palpation. Tenderness often extends downward over the course of the ureter and may be elicited by pressure upon the abdomen. If the pyelitis is on the right side, the kidney infection may be confused with appendicitis. No pregnant woman should be operated on for appendicitis until the presence of a right-sided pyelitis has definitely been excluded. This is, as a rule, not difficult. The renal tenderness and pyuria speak strongly for a kidney infection. In addition, the fever is usually higher in pyelitis than in appendicitis and the leukocytosis is more marked. If necessary, cystoscopy and ureteral catheterization will give a positive answer to the question.

Treatment.—It is possible that the number of cases of pyelitis of pregnancy may be lessened by the recognition of and attention to foci of infection from which bacteria may get into the blood stream. Correction of the constipation which is often present during pregnancy may decrease the migration of colon bacilli from the bowel into the blood stream and thus diminish the possibility of infection of the kidney.

After the appearance of the infection treatment consists in the use of liberal amounts of water in order to promote a free flow through the kidney and ureter. Rest in bed and a bland diet are essential. Drugs have only a limited value. Formerly hexamethylenamine was frequently used, enough of the drug being given to produce a positive reaction for formalin in the urine. In order for this to occur it was necessary for the urine to be acid in its reaction, this being brought about if necessary by the administration of acid sodium phosphate. Of late years the alkalies have been more frequently employed. Sodium bicarbonate 2 Gm. (30 grains) every four hours is ordinarily enough. Larger doses may be used if needed. Sodium citrate may be used instead of sodium bicarbonate.

Postural treatment was highly valued at the time at which it was supposed that ureteral obstruction was caused by pressure upon the ureter by the fetal head. It apparently has some value and should be included among the palliative measures which may be employed. As pyelitis of pregnancy most often affects the right kidney, and as a dextrotorsion of the pregnant uterus is frequent if not usual, it is possible that lying upon the left side may, by partially correcting the rotation of the uterus toward the right, to some extent relieve the obstruction at the lower end of the right ureter. Whatever the explanation may be, lying upon the side opposite to that upon which the infection is located appears in some cases to be beneficial. The knee-chest position may also be used and in some cases appears to be helpful.

Hofbauer[3] suggests the use of pituitary extract in order to produce vigorous peristalsis of the ureter and thereby accelerate the urinary flow. It has long been known that an atonic bladder may be stimulated to contract by the use of pituitrin and later roentgenographic studies have apparently demonstrated that active contractions of the ureteral musculature may be produced by it. Clinical evidence, with the exception of a few cases observed by Hofbauer, is lacking.

If improvement does not follow the use of the measures just described, the ureter on the affected side should be catheterized. The catheter may be allowed to remain a few hours in order that the kidney pelvis may be thoroughly drained. It has been suggested that the catheter be left in place twenty-four hours or even more. The use of the indwelling ureteral catheter

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VITAMINS IN PREGNANCY

The relation of the vitamins to pregnancy and lactation is continually becoming more important if we may judge by the light thrown on this subject by recent research. It must be admitted, however, that the problem is still largely in the experimental stage, because of the lack of knowledge of the intimate nature of the vitamins and the inability to determine the vitamin requirements of the normal individual from a quantitative standpoint. A further difficulty is encountered in that there is no method of determining quantitatively the vitamin content of foods. Thus, many factors are missing, without which it is impossible to obtain a great deal of information at the present time.

It should be borne in mind that in this consideration the importance of the vitamins is confined not only to those that have a specific influence upon the reproductive tract, pregnancy, and lactation, but to all of the known vitamins as well, because of their influence upon the integrity of the organs and systems of the body as a whole. This concept is emphasized by Browning,[6] who calls attention to the necessity of considering the vitamins in a broad sense, for the fundamental factors of vitamin disturbance lie in the elements of metabolic function. In this she agrees with McGarrison, who states that in vitamin deficiencies there is a depression of cellular function which ultimately leads to disease.

Most of the specific data concerning vitamin deficiencies in relation to pregnancy and lactation have been obtained from animal experiments. In spite of the small amount of material of a specific nature available, I have selected from this only what seems to have a direct connection with the problem at hand. Though it leaves much to be desired it will serve to emphasize certain fundamental facts which lie within the scope of this discussion.

Vitamin A.—Reynolds and Macomber observed that rats maintained upon diets deficient in vitamin A failed to show normal reproduction. Diets containing adequate amounts of this vitamin permitted the animals to reproduce normally. Evans and Bishop[10] have shown that deprivation of vitamin A produces sterility in the experimental animal by the production of a cornification of the epithelium of the genital tract which interferes with implantation of the fertilized ovum. Sherman and MacLeod[24] found normal reproduction in experimental animals on diets adequate in vitamin A, but it should be noted that diets which contained only sufficient vitamin A to permit growth were not adequate for either reproduction or lactation.

were often premature and showed underdevelopment. When the animals were placed on the deficient diets later in pregnancy the young were born alive and were fully developed, though they had latent scurvy which became acute if the mother continued on the diet and if the young had to depend upon her milk. He found, further, that the mortality rate was higher in pregnant animals on the vitamin C deficient diets than in those not subjected to the demands of pregnancy or lactation.

Reyher, Walkoff, and Walkoff[22] conducted their studies upon guinea-pigs deprived of varying amounts of vitamin C during pregnancy. They found that 40 out of 110 animals became pregnant when maintained on diets deficient in vitamin C. Animals on a markedly deficient diet developed scurvy and their pregnancies terminated in from twenty to thirty days, by abortion. These mothers died subsequently from scurvy. On less deficient diets, litters were born but the newborn animals were reduced in size and weight. On the least deficient diets the mothers went through their pregnancies normally. They maintained normal weight gain and showed no external evidences of disease. Histologically, these mothers and newborn showed definite, but mild, pathologic scorbutic changes. The maternal changes included hyperemia of the capillaries of the joints, and teeth pulp deficient in calcium and in dentine formation. There was a decrease in the number of red blood cells in the circulating blood. The newborn animals showed these same changes though they were less severe in character.

Vitamin D has been shown by Hess and his associates[14, 16] to be essential for the embryonic development of the chick and the fish. Hess[13] states that up to the present time little or no effort has been made to combat rickets by prenatal care, nor is it known how much can be accomplished in this way. He quotes his work in collaboration with Weinstock,[15] in which an attempt was made to prevent the occurrence of rickets in a group of infants by giving their mothers cod liver oil during the last two months of pregnancy. Their attempt failed as almost all of the babies developed rickets during the subsequent winter. It is his opinion that rickets can be prevented only to a certain degree by feeding prospective mothers adequate vitamin D during pregnancy.

Blunt and Cowan[5] conclude that in the human female as well as in animals during pregnancy and lactation, there is little doubt that care of the diet, including the feeding of cod liver oil and exposure to sunshine, are vitally important in safeguarding the maternal organism as well as her offspring.

The recent paper of Richardson[23] is of interest. He states that viosterol is of definite value during pregnancy in the relief of tetany and the toxemias of pregnancy. He has clinically shown that the bleeding and clotting time of the parturient is reduced. He attributes these results to the influence of viosterol upon calcium and phosphorus metabolism.

Vitamin E.—The existence of an antisterility vitamin E, formerly called vitamin "X," was discovered by Evans and Bishop in 1922. Since then numerous investigators, including Mattill, Carman and Clayton, Mason, Evans and Burr,[11] Suzuki and associates, Bisceglie,[4] Urner,[27] and others have confirmed the specificity of this vitamin upon the embryo, membranes, and placenta as well as its specific effect on the testes of the male rat. Adamstone[1] has studied the effects of vitamin E deficiency on the development of the chick.

mentally it has been found that there is a higher mortality during pregnancy when animals are deprived of vitamin C than in the nonpregnant animal on the same diet.

Vitamin D has been shown to be necessary for the embryonic development of the chick and the fish. There is no evidence to show that it offers an immunity to rickets in the newborn, even when adequate amounts are fed to the mother during the pregnant period. The importance of this vitamin in its relation to the metabolism of calcium and phosphorus is well recognized and as such may offer a great deal in maintaining normal pregnancy.

Vitamin E is necessary for the development of the embryo and the successful termination of pregnancy. It is necessary for the proper nutrition of the suckling young. As for vitamin B, its requirement is increased during lactation. All investigators have had difficulty in producing the specific effect of a deficiency of this vitamin because of the fact that it is so universally distributed and is stored in the body. It is doubtful whether it plays an important rôle in the human unless there are unknown factors that interfere with its proper utilization.

In conclusion, the value of a well-balanced diet, including the vitamins, should be emphasized during the pregnant and lactation periods as it is the easiest and most natural means of supplying every food constituent. We are not always certain, however, that there are not factors, as yet unknown, that may interfere with the proper utilization of any nutritional element or elements and thus produce abnormal metabolism which may ultimately lead to disease.

In the present state of our knowledge we can only increase our vigilance in regard to the general condition and the nutrition of a patient during the pregnant period. The presence of anemia, lowered resistance, tetany, and early symptoms of toxemia should be considered at least in part from the standpoint of the nutrition of the patient, and the missing factors added when possible by dietary adjustment or specific substances when they seem indicated.

A great deal of research has been done in this interesting field of nutrition, but there remain many problems of a specific nature to be solved. For the present we will be obliged to carry on with more or less empiricism.

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an acme and then gradually recedes, a condition spoken of as *increment, acme,* and *decrement.* The total duration of a labor pain is approximately one minute. This active process is followed by a pause, a complete relaxation of the muscle. The acme of the pain is short in duration, the greater part of the pain being taken up by the increment.

There seems to be an individual variation in the sensitiveness to labor pains as exhibited by the patient in labor. Some experience such acute agony that a life-long impression remains, but occasionally the suffering is very slight, almost painless in some instances. The pain starts usually in the lower lumbar or in the sacral region and slowly radiates to the abdomen and down the thighs. It is thought that in the early part of labor the pain is due to pressure exerted on the nerve endings lying between the muscle fibers; that later it is increased by the dilatation of the soft parts and is most marked when the presenting part dilates the vulva just prior to its expulsion.

As was stated above, at the beginning of labor the pains may occur at intervals of from ten to thirty minutes. As labor progresses they increase in frequency and intensity. Toward the end of the process the interval between pains may be one or two minutes. Occasionally the interval is less than one minute. The average duration of a pain is one minute, but it may be as short as thirty seconds or as long as ninety seconds.

Causes of Labor.—The desire to explain the cause or causes of the onset of labor has always stimulated extensive inquiry and speculation. Up to the present time, however, no theory has been advanced which establishes definitely a universal cause. Some of the most important theories which attempt to explain the onset of labor are the following:

1. Increasing irritability of the uterine muscle.
2. Pressure upon the nerves of the lower uterine segment and on the cervical ganglion occasioned by the increasing distention of the lower uterine segment.
3. The changes which occur in the decidua during the latter half of pregnancy.
4. Increased "venosity" of the placental blood with its resultant irritation of the uterine ganglia.
5. Dilatation of the cervix by the presenting part.
6. The mechanical factor of the increasing distention of the uterus.
7. Senility of the placenta.
8. Menstrual periodicity.
9. The circulation in the maternal blood of a fetal antigen which is responsible for the production of an anaphylaxis.
10. As a result of certain emotional states or physical states.
11. Habit and heredity.
12. Maturity of the fetus.
13. The influence of certain hormones.

1. It is well known that as pregnancy progresses the uterine musculature becomes increasingly more irritable. While, in the early months of pregnancy, strong chemical or mechanical stimuli are necessary to cause any increased contraction, toward the end of pregnancy the slightest stimulus causes contraction. During the last weeks of pregnancy the sensation of labor pains

the uterus would contract in an attempt to empty its cavity of the fetus. This, however, seems to be demonstrable only in pathologic cases, such as in the premature labors which take place in cases of hydramnios and of multiple pregnancy. However, it must be pointed out that even in cases of extreme distention labor does not always occur; such are cases of prolonged pregnancy with large children. Wielock[52] has shown in his experiments on intra-uterine pressure by the use of the manometer that the pressure in cases of hydramnios varied but little from the pressure in normal cases.

7. If we examine routinely the placentae of patients delivered at term we find infarct formation to a greater or less degree. Williams[54] states that small subchorionic infarcts are present in every placenta, and that infarcts measuring 1 cm. or more in diameter were present in 63 per cent of 500 consecutive placentae. He, as well as Eden,[14] considers the presence of these infarcts as evidence of senility of the placenta. When large areas of the placenta are occupied by infarcts there is, most certainly, a disturbance of the fetal circulation, which, in turn, might be responsible for the onset of labor pains. Here, again, we have a theory which would be applicable in only a small percentage of cases for the number of placentae showing such marked infarct formation are few.

8. Certain investigators, among them Löwenhardt[35] and Beard[5] believe that the uterine contractions are more marked at the times when the patient would ordinarily have her menstrual period if the amenorrhea of pregnancy were not present, that these become maximal at the time of the tenth menstrual period and thus cause labor pains. This would lead one to suspect that there was a hormone circulating in the maternal blood, probably ovarian in origin, which increased in quantity as the pregnancy progressed and at a certain concentration stimulated the uterus to contract.

9. The theory that an anaphylactic reaction occurs in the maternal organism due to the presence of fetal substances in the maternal blood has not been confirmed by experimental investigation.

10. In obstetrical practice it is a recognized fact that any sudden shock, an accident, violence, a blow on the abdomen, violent exertion, emotional states such as extreme fear, anger, or sorrow may cause the onset of labor. DeLee[11] cites the case of a patient who walked up and down six flights of stairs in a hotel and was successful in starting up labor. However, at the time of delivery it was found that there was a small area of premature separation of the placenta. These causes should be regarded only as contributory in most instances and not as primary causes of the onset of labor.

11. The cause of the onset of labor at the customary time, according to Geyl,[17] is due to the fact that nature has found this to be the most suitable time. There is no method by which we can prove or disprove this theory. We do know, however, that when the child is delivered prematurely its chances of survial are poor and that when the child is delivered postmaturely the labor is usually difficult and often results in death of the child.

12. Fetal changes rather than maternal changes may account for the onset of labor pains. Spiegelberg[46] maintained that the cause of the onset of labor might depend entirely upon the maturity of the fetus. He set forth the theory that certain chemical substances which were used by the fetus in the process of its development but which were excreted by it as maturity approached were transported to the maternal blood in quantities sufficient

hours usually caused a "regular" but "delayed" abortion forty-eight hours after the last injection.

5. A dosage of oestrin which has been found incapable of producing abortion alone, followed immediately by an injection of oxytocin caused an immediate "regular" abortion in the majority of tests.

Thus, it would seem that oxytocin acts on the uterine musculature only after the uterus has been sensitized by oestrin.

The onset of labor may be explained, not upon the basis of the action of a single hormone, but rather upon the interaction of several hormones. During pregnancy oestrin is produced in increasing amounts up to the time of delivery while at the same time progestin (the hormone of the corpus luteum which is a factor, at least, in making the uterus insensitive to the action of oestrin and oxytocin) decreases in amount as the corpus luteum disintegrates. Thus oestrin becomes the dominant hormone, sensitizes the uterus to oxytocin, and oxytocin then stimulates the uterus to expulsive contraction. This is the theory as explained by Graves.[18] There is a correlation of the activities of the hypophysis and the ovaries but there still remains much to be explained concerning this correlation. There is still a large field for research upon the rôle which the other glands of internal secretion may play in the onset of labor.

Much work has been done by Williams,[54] his associates, and others in an attempt to explain the onset of labor on a biological basis. Observations have been made showing that certain changes in metabolism occur just before and during labor which may play a rôle in the initiation of labor.

Slemons[45] showed that during the twenty-four hours prior to the onset of labor the nitrogen content of the urinary output is diminished, accompanied by a marked diuresis. In studying the metabolism of two patients in whom labor was artificially induced (by means of a bougie) these same changes were not found, or if found were present in a less pronounced degree than in the patients in whom labor was spontaneous. He concluded that it was probable that there was some substance circulating in the blood which could not only change the metabolism, but which also had the property of stimulating the uterus to contraction.

Perez,[39] on an experimental basis, arrived at the same conclusion. He injected citrated blood obtained from women in labor into the venous circulation of women who were past term. This experiment was carried out on a series of 50 patients. Between 50 and 60 per cent of these cases went into labor. Twenty-five patients who were injected with blood from patients in the last month of pregnancy failed to go into labor. Therefore, Perez[39] concluded that there must be some specific substance present in the blood of patients in labor.

We have as further confirmation of the changes in metabolism which occur at the end of pregnancy the work of Zangemeister[55] in 1916. He found, during the last months of pregnancy, a daily increase in weight amounting to 55 to 60 Gm. This increase in weight continued, unless the fetus had died in utero, until within three or four days of the onset of labor when there was noted a sudden loss of approximately 1000 Gm. This was found to occur so constantly in the series of cases observed that a prediction as to the time of onset of labor could be made several days prior to the actual onset.

with the fetal head. This bag was then connected to a manometer and the variations in pressure were recorded on a rotating drum and also were read off on a column of mercury. Kehrer[24] recorded the force of the pains throughout the entire period of labor. He found that the intra-uterine pressure in the pause between contractions was 20 mm. of mercury. During a pain the column of mercury rose to as high as 250 mm. in some cases.

Other attempts have been made to measure the force exerted by inserting a dynamometer between the operator and the handle of the forceps in forceps deliveries. These experiments showed that the force necessary to deliver the fetus rarely went above 80 pounds. Schäffer[40] and others have attempted to obtain some idea of the force exerted by measuring the abdominal pressure.

Guggisberg[19] points out that the methods of investigation in which a manometer is used all have one fundamental error, in that manometry in the pregnant uterus is founded on a purely statical principle and no consideration is given to the fact that the uterus is in motion. He maintains that the intra-uterine pressure represents an unknown physiologic quantity and that for the practical purposes of the obstetrician, inspection and palpation are the best methods of measuring the force exerted.

Physical Changes during the Uterine Contractions.—When the uterus contracts during the pain, it undergoes very definite changes. In the flaccid state, with the patient in the lithotomy position, the uterus is resting upon the vertebral column. However, when a contraction takes place, the uterus no longer rests upon the vertebral column but rises in the abdomen, pushes the anterior abdominal wall forward, increases its anteroposterior diameter, decreases its transverse diameter and becomes pear-shaped.

At the same time that the uterus is undergoing the above changes the ligaments which support it also contract. The round ligaments aid in drawing the fundus of the uterus forward and in maintaining it in this position during a contraction. They stand out sharply and may be palpated with ease through the abdominal wall.

During the second stage of labor the abdominal and respiratory muscles are brought into action. During uterine contractions in the second stage of labor the patient inspires deeply, closes the glottis, and uses the abdominal and respiratory muscles in the supreme effort of expulsion of the fetus. Thus the intra-abdominal pressure is increased markedly.

In addition to these changes certain general systemic changes occur during the labor pains. Clinical observations have shown that there is an elevation of the blood pressure during the pain. The pulse becomes more rapid during the pain but becomes slower in the interval between pains. The respirations become slower during the contraction but are more rapid in the period of relaxation. In the second stage of labor respirations are absent altogether during the expulsive pains.

Investigations have been carried out by Hofbauer[21] and by Ivy, Hartman, and Koff[22] on the changes occurring in the uterus during contractions. Hofbauer[21] describes in the following manner changes which he has observed in the uterus during cesarean section following the injection of pituitrin: "A pale band from 2 to 3 inches wide, composed of parallel fibers, is visible over the anterior surface all the way from the bladder reflexion to the fundus, in its pattern resembling the tenia of the large intestine. The wave of contraction spreads from this band and involves an ever-increasing area of the

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as labor advances and a lower, passive segment which becomes thinner and larger. As long as the membranes are intact the forces of the contracting uterus are applied to the fetus through the amniotic fluid, and therefore are of equal intensity in all directions. Since the lower uterine segment and

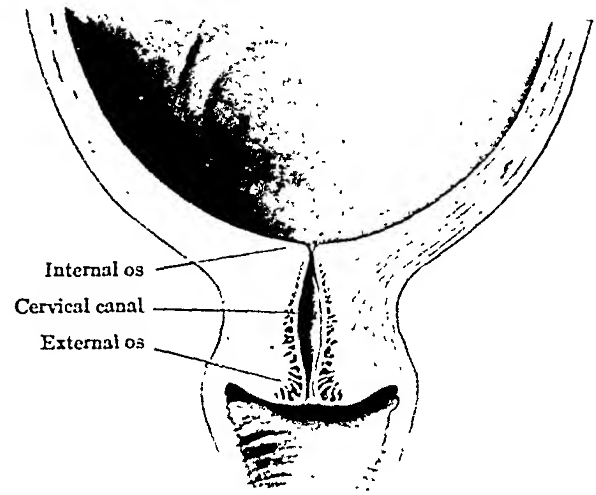

Fig. 362.—Cervix of a primipara at the beginning of labor. (Bumm.)

cervix are pierced by canals they form the area of least resistance. Stieve[47] has shown that early in labor the fetal membranes in the region of the lower uterine segment become separated and are forced into the cervical canal by the contractions of the uterus. This causes early expulsion of the cervical mucous plug which carries with it almost all of the hypertrophied glands of

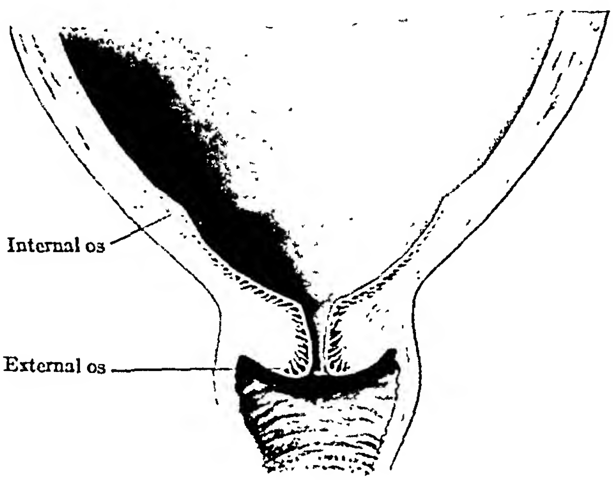

Fig. 363.—Cervix of a primipara during first stage of labor. Partial obliteration of canal. (Bumm.)

the cervix and some of the blood from the dilated cervical vessels. Thus, a relatively wide area of cervix is early exposed to the hydrostatic action of the enclosed amniotic fluid, or in the case of premature rupture of the membranes, to that of the presenting part.

lateral and anteroposterior diameters. These changes in shape are caused both by the increased thinning and enlargement of the lower uterine segment as well as by the straightening of the fetal ovoid. As labor progresses the uterine corpus becomes increasingly thick so that by the time the presenting part reaches the perineal floor more than half of the body of the child lies below the contraction ring.

In the second stage of labor the reinforcing effects of the abdominal muscles come into play. At first voluntary, as the second stage advances the patient

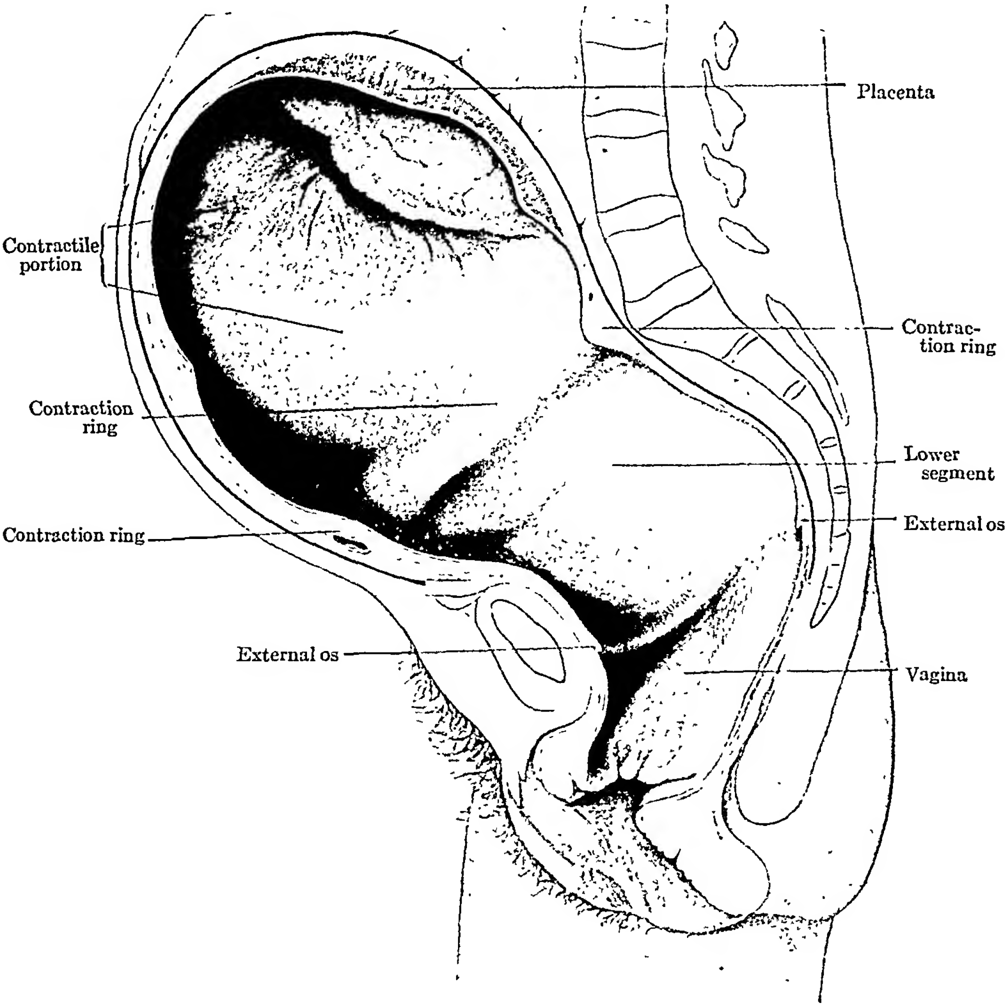

Fig. 366.—Frozen section through woman dying at beginning of second stage of labor. (Bumm.)

finds it almost impossible to inhibit the contractions of the abdominal musculature. Schroeder[43] states that the birth of the child is due solely to the expulsive forces of the abdominal muscles, in which Bumm[9] agrees; on the other hand, according to Olshausen,[37] birth is accomplished by the combined expulsive efforts of the uterus and abdominal muscles. The importance of the latter is clearly seen in parous women with extreme lack of tonicity of the abdominal muscles, in whom the second stage is frequently so prolonged as to necessitate operative interference.

A marked difference in size and development of the embryos in the uterus suggests the possibility of superfetation. This is usually explained, however, by the interference of one twin with the circulation of the other, as may occur in cases of uniovular twins which always have a common placenta.

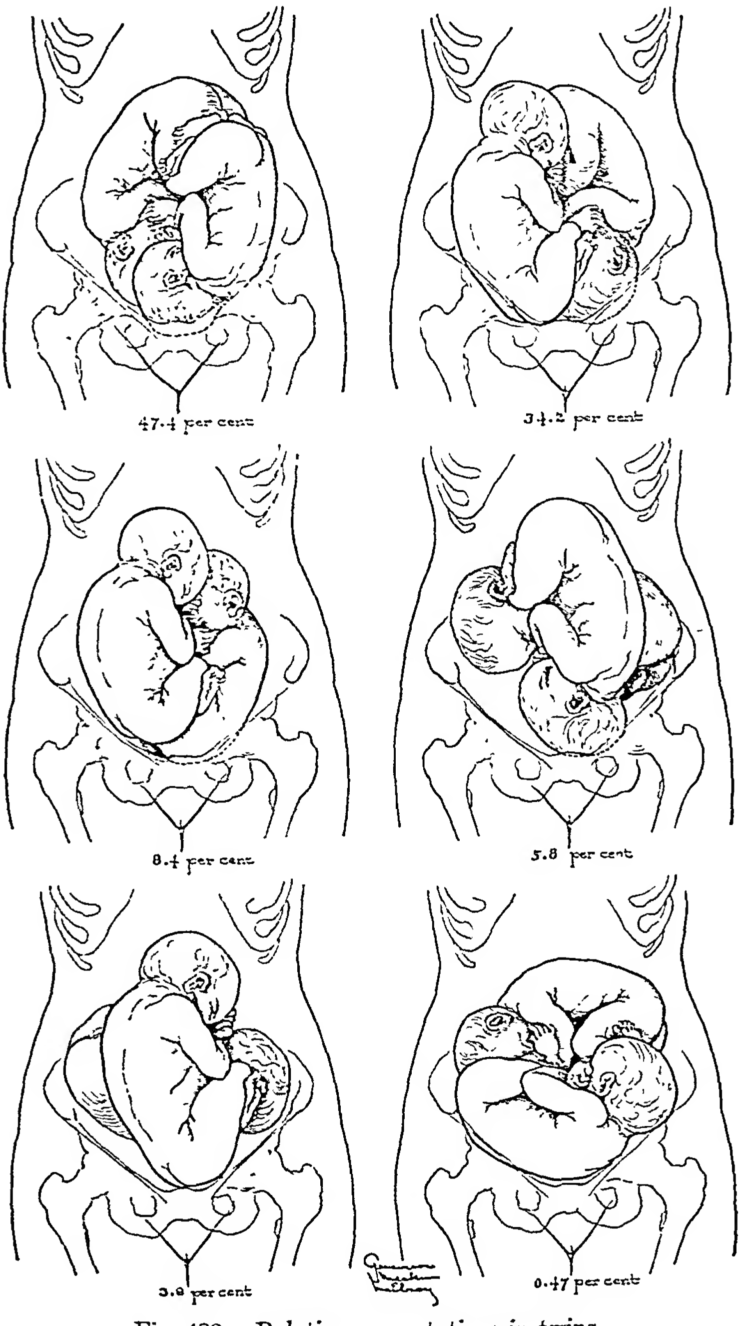

Fig. 483.—Relative presentations in twins.

Clinical Course.—The subjective symptoms of pregnancy are usually exaggerated due to the double burden of fetal metabolism, and later, to the increased weight and abdominal distention. Nausea and vomiting are often excessive and more persistent than in single pregnancy, and edema of the

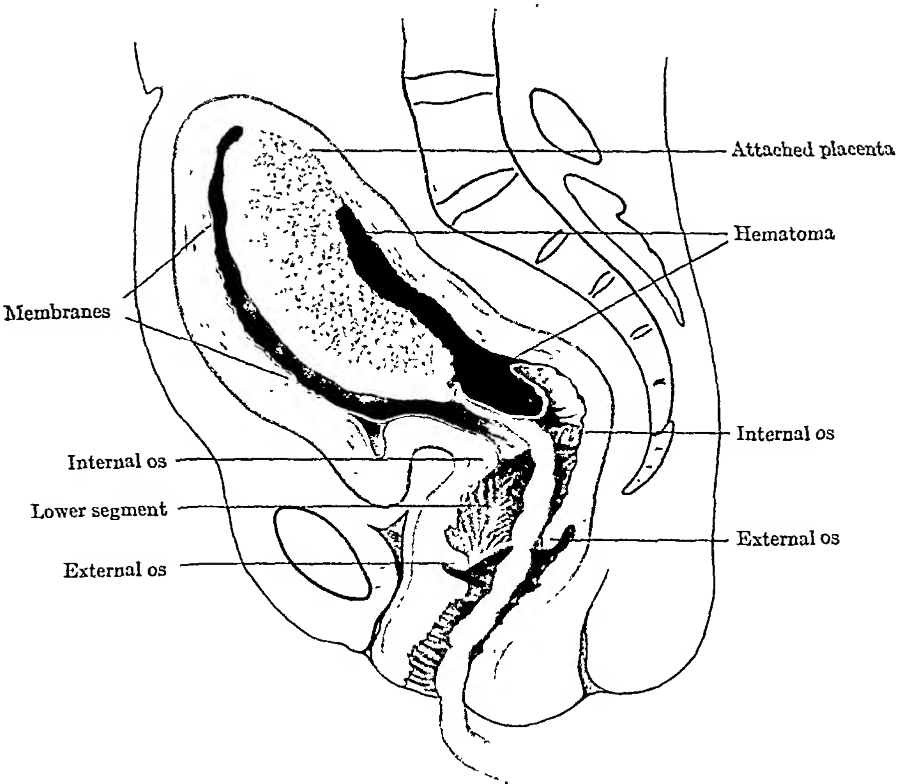

Fig. 370.—Partial separation of placenta in third stage—Duncan's mechanism. (Bumm.)

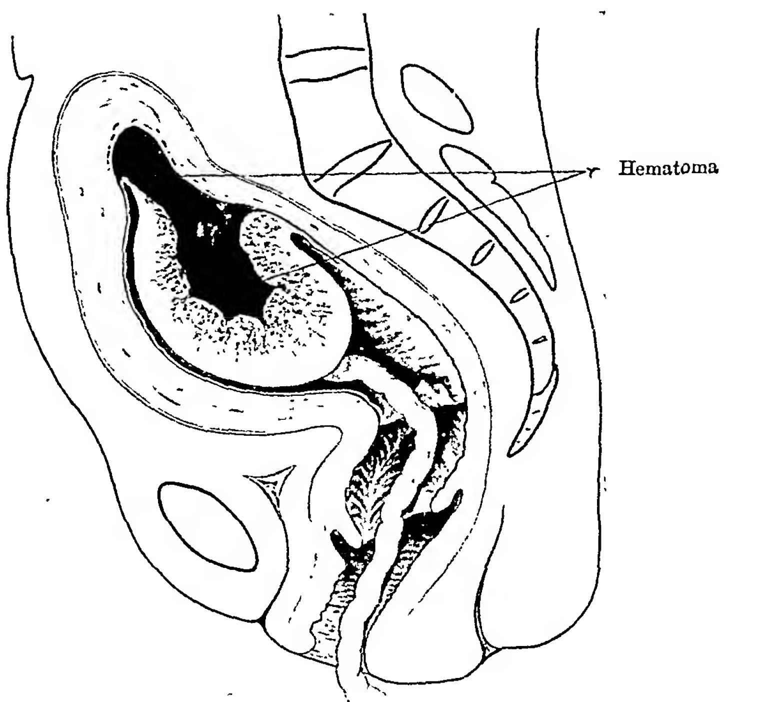

Fig. 371.—Partial separation of placenta in third stage—Schultze's mechanism. (Bumm.)

of the mucous plug which has filled the cervix during pregnancy. During this prodromal stage the patient has probably experienced several attacks of "false" labor pains, often occurring at night, with rhythmical pains especially in the back but which quickly subside. All of these prodromal phenomena may be absent, especially in multipara, in whom labor often begins acutely.

Labor is usually divided into three stages for descriptive purposes: The first, or stage of dilatation, begins with the onset of regular and painful uterine contractions and ends with complete obliteration and dilatation of the cervix. The second stage, or period of expulsion, begins with complete cervical dilatation and ends with the birth of the child. The third stage, or placental period, begins with the completion of the delivery of the child and terminates with the expulsion of the placenta.

First Stage.—While we speak of the onset of labor as occurring with the beginning of painful and regular uterine contractions, it is often difficult to determine the exact time of onset. In the beginning the pains come infrequently, last only a few seconds and between pains the patient is perfectly comfortable. The pain is cramplike in character, most pronounced in the lumbar region, and, since labor is at times initiated by the rupture of the membranes, is accompanied by the escape of varying amounts of amniotic fluid from the vulva. The time of rupture of the membranes by no means coincides with the beginning of the second stage. Rupture may occur at any time during the first stage, at the onset of labor or several hours before, or, in rare instances, as much as several weeks before labor begins. While the latter statement is true, it is usual for labor to begin within twenty-four hours after the escape of amniotic fluid. On the other hand, the membranes may not rupture until the second stage is well advanced; and in fact, the child is occasionally born completely surrounded by the intact membranes. The amount of fluid escaping at the time of rupture depends upon the location of the point of rupture and more particularly upon the position of the presenting part. In vertex presentations with the rounded head low in the pelvis only the fluid in the front of the head escapes; while if the head is high in the pelvis or the breech is occupying the superior strait the entire amount of amniotic fluid may escape.

Second Stage.—With the onset of the second stage the character of the pains undergoes a marked change. Their intensity, frequency, and severity again increase and the patient experiences a desire to expel the child. This is accomplished by bringing the abdominal muscles into play, at first voluntarily, but as labor progresses the patient finds it difficult to inhibit the desire to bear down. At the onset of each contraction, she braces her feet against the foot of the bed, takes a deep inspiration, closes the glottis and brings the abdominal and respiratory muscles into activity, the effort being accompanied by a characteristic grunting sound. During the contraction the uterus is ligneous in consistency, the veins of the neck are distended, the color high and the face bathed in perspiration.

The perineum begins to flatten out and the anus to open. Due to the pressure on the rectum by the advancing head the patient has the desire to defecate, and unless the lower bowel is completely empty small particles of fecal material are expelled with each pain. As the second stage progresses the perineum becomes thinner and thinner and begins to bulge with each

tieth year. This is denied by Varnier,[48] Williams,[54] and others, and refuted by the recent statistical study of Calkins, Litzenberg, and Plass.[10] There is a prevalent belief that more babies are born at night than during the day. This view probably arose through the fact that in most labors either the beginning or the end occurs during the night hours. At any rate it is not substantiated by the findings of DeLee,[11] Knapp,[27] Williams,[54] and others.

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SECTION V

LABOR

CHAPTER XXIII

THE MECHANISM OF LABOR IN VERTEX PRESENTATIONS

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The mechanism of labor comprises that series of forces and resistances by whose action a hard, somewhat compressible and fairly flexible body, the fetus, is thrust into, through and finally out of an irregularly circular canal, sharply curved in its lower third; the maternal pelvis. The process is a complicated one, much more so in human beings than in the lower mammals, and its details are not yet clearly understood, although the general principles were clearly stated by such writers as Baudelocque and Smellie and were closely described by Naegele in his essay of 1819. This whole complicated process has been much studied, generally by repeated digital examination of the parturient woman, lately by repeated roentgen photography during labor, and in some instances by the immediate inspection of the parts in women who have perished intrapartum.

A necessary preliminary to a study of the mechanism of labor is a clear understanding of the anatomy of the pelvis and pelvic floor, the physiology of the birth processes and the position and presentation of the fetus in utero, all of which have been previously described in this work. The seemingly unnecessarily complicated mechanism of labor in the human female is generally regarded as one of those disharmonies of reproduction so well described by Metchnikoff (The Nature of Man). Evolution in developing the cerebrum of man, causing him to assume the upright position rather than the horizontal one of a former quadruped existence, and in decreasing his musculature, caused also marked alteration in the contours of the pelvis and in the shape and size of the fetal head. In order to approach this subject it is well first to consider very briefly the structure of the pelvis and the mechanism of labor in quadrupeds. The pelvis in the lower orders is of much greater length from the crests of the ilia to the tuberosities of the ischia than in man. The ilia, instead of forming a large, concave basin-like enclosure, are narrow and wing-shaped, and enclose a cavity with almost parallel side walls. The symphysis pubis, in man a narrow synchrondrosis a few centimeters in length, is in the lower animals a joint of about one half the entire pelvic length. The false pelvis, in quadrupeds, consists only of a small portion of the narrow ilia which flare widely apart above the sacrum. Almost all of the pelvic girdle may be said to be included in the true pelvis (Figs. 372, 373). The increased length of the symphysis naturally causes a wide variation between the true conjugate and the diagonal conjugate diameters.

It will be seen that, among quadrupeds, in the passage of the fetus under the promontory of the sacrum, it meets with no bony obstacle below, since

as described, and upon the contour of the presenting part which, if cephalic, is a pointed cone, the long snout forming an ideal wedge for producing dilatation. Internal rotation, in the sense of its occurrence in the human species, is absent, *i. e.*, there is no rotation of the presenting part upon the pelvic floor as in man, but the movement is rather an accommodation of the greatest diameter of the fetal body in cross section to the greater axis of the mother, that is the dorsoventral.

The course of the fetus through the pelvis is as follows: The sacral promontory is passed without difficulty since there is no bony obstruction on the opposite ventral surface and the promontory is only opposed by the maternal soft tissues and the abdominal muscles. The first critical point in the traverse of the pelvis is reached when the presenting part must rise over the sharp ridge of the symphysis pubis. This obstruction passed the young animal enters the midpelvis, encompassed by the pubes below, the ischia and ilia laterally and the somewhat movable sacrum with the root of the tail above. When this strait is passed the critical period is over, the fetus now entering the outlet where the tuberosities of the ischia, flaring apart, form the lateral walls, the ascending rami of the pubes and ischia, the floor and the freely movable tail, the roof. The perineum now dilates and the forelimbs and head are born, rapidly followed by the trunk and hind legs. The phenomenon of external rotation does not occur as the fetal body has occupied its final presentation from the beginning of labor.

Before dismissing the subject of pelvic anatomy, it is interesting to speculate upon the effect of the gradual assumption of the upright position on the part of man upon the morphology of the pelvic girdle, it being apparent that certain changes in the architecture of the pelvis would gradually supervene.

The weight of the trunk above, causing a thrust of the sacrum downward and backward, would effect a gradual change in the center of gravity, tending to force the acetabula forward and the spinal column backward. The trunk weight would also produce a dropping or pushing backward of the bodies of the ilia, increasing the angle of this portion of the bone. The sacrum would rotate on its axis, throwing the promontory forward and the coccyx backward. The upward push of the legs upon the acetabula, together with the pull of the great muscles of the back, would force the symphysis forward and upward, decreasing the angle of the superior strait. The pressure downward of the abdominal viscera would naturally require more bony support with a resulting growth of the wings of the ilia forward, their surfaces becoming concave (Fig. 374).

With these mechanical forces operating during countless generations, it becomes readily apparent that the resulting pelvis would of necessity be a basin-shaped cavity, with broad, expanded iliac bodies, a short symphysis, and acetabula well forward of the axis of the sacrum, which bone would have its promontory sharply directed forward—in other words, a pelvis of the human type.

If one were asked to construct a pelvis around an ideal bony canal for the passage of the human fetus, it would doubtless take the form of a funnel-shaped, bony basin, its cavity corresponding accurately to the contour of the flexed fetal head, and its segment of greatest contraction as short as consistent with rigidity sufficient to resist the pull of the great muscles. There should be no obliquity of conformation, the bony canal being at the same height at all points.

not an integral or even mechanically desirable method of accomplishing the object in view.

With regard to the single purpose of acting as a channel of egress for the fetus, the ideal birth canal as described would be perfect, but it must be remembered that all the functions of the pelvic girdle, some of them of constant, vital necessity, must be considered, and that it is the combination of uses, the modification of one detail to permit the introduction of another, which has resulted in the human type of pelvis as it now exists. With this understanding of the general morphology of the pelvis one may proceed to a discussion of the mechanism of labor in the human female. The factors concerned in the mechanism of labor may be defined as:

1. An irregular and moderately elastic cylinder (the fetal body), to which is attached at one extremity a slightly elastic ovoid (the fetal head), the connection between the two being by means of a freely moving universal joint (the craniovertebral articulation).
2. A short inelastic cylinder, sharply curved at its lower end and having its posterior length several times greater than its anterior length (the pelvic canal).
3. Certain forces of expulsion (the involuntary contraction of the uterine muscle, plus the voluntary contractions of the abdominal muscles), the combined effects of these forces being to cause the descent of the fetus through the pelvic canal.
4. Certain forces of resistance—the bony pelvis, the cervix uteri, and the muscles and fasciae of the pelvic floor—which tend to obstruct and delay expulsion and which exert a powerful influence in determining the direction in which the fetal body shall traverse the pelvic canal and in causing such molding of its more elastic portions as shall permit such passage and subsequent expulsion with a minimum of obstruction.

The mechanism of labor may readily be divided into three phases: First, engagement, during which the fetal presenting part is molded, compressed, and forced into the pelvic inlet; second, rotation and descent, during which the presenting part is made to conform to the varying shape of the pelvic cavity, and to pass through it, together with the dilation of the soft portions of the birth canal; third, disengagement or extrusion, during which the fetus finally passes through the pelvic outlet and over the distended perineum to be born.

Flexion, Molding, and Engagement.—In between 95 and 97 per cent of all cases the fetus in utero presents by the vertex, *i. e.*, the vertex of the fetal skull lies in the center of the plane of the superior strait.

This frequency of cephalic presentation has been the subject of much controversy, but is now generally explained by Pajot's law of accommodation, which states that when an ovoid body lies free in an ovoid container the two long axes tend to become parallel, which is especially true if the container possesses contractile power. The fetal ovoid, then, tends to conform to the equally ovoid cavity of the uterus.

From early pregnancy the head of the child is in the lower portion of the uterus, the reason being probably that in the young embryo the specific gravity of the cephalic extremity is higher than that of the caudal. As the fetus grows, its limbs develop rapidly so that the caudal portion with the legs flexed on the abdomen is greater in bulk than the cephalic portion and therefore naturally fits more easily into the broader upper portion of the uterine cavity.

The infectious diseases complicating pregnancy offer an interesting problem which may best be viewed from two angles. In the first place, certain chronic infectious diseases, as pulmonary tuberculosis, clearly antedate pregnancy, and the majority of such patients showing clinical activity during child-bearing represent a state of relighting dependent upon the added strain; but there are some instances in which the disease has its first clinical expression at this time. The second proposition deals with the acute infectious diseases to which the pregnant woman may be exposed. Pregnancy apparently confers no immunity but rather an increased susceptibility to most of these diseases.

The hazards of such complications to the mother and to the offspring are many and varied. Hence they must be discussed separately. In such a presentation it is apparent that only the more important subjects can be outlined. Personal judgment may differ as to the inclusion or omission of certain material; but, in general, attention has been directed toward the problem of the general practitioner as related to the medical complications of pregnancy.

DISEASES OF THE DUCTLESS GLANDS

Thyroid Gland

Supplying the hormone for the control of bodily metabolism the thyroid gland would naturally be expected to undergo certain changes during pregnancy. The appreciable enlargement of this gland during puberty, menstruation and pregnancy does not occur if the iodine supply or the available thyroid hormone be adequate, according to Marine.[1] Histologic changes in the thyroid gland have never been satisfactorily demonstrated during the sexual cycles of animals. Marine[1] insists that in the human being there is no cellular hyperplasia unless the iodine content of the gland falls below 0.1 per cent of its dried weight. At this level the so-called "work hypertrophy" of the thyroid gland occurs and it differs only in degree from the colloid or simple goiter. Bokelmann and Scheringer[2] have determined an actual increase in the iodine of the blood in the seventh, eighth and ninth months of pregnancy. The studies of the basal metabolism during normal pregnancy show a rise averaging + 20 to + 25 per cent in the late months of pregnancy.[3, 4] Pommerenke, Haney and Meek,[5] by dissociating the fetus from the mother in rabbits and computing body surfaces, found that the total heat production of the mother before parturition was about equal to that of the mother and young combined after delivery. Hence they concluded that there was no actual increase in maternal basal metabolic rate in pregnancy. Root and Root[3] found that the basal metabolic rate postpartum fell to a level of 9.6 per cent below that of the fourth month of pregnancy even though the body weight remained stationary. The application of basal metabolism studies for the determination of the fetal life, as suggested by Baer,[6] would presuppose the interruption of a regular curve of increase from the fourth month. Isolated determinations would have no value. Carpenter and Murlin[7] proved that the total energy production of the mother and child is not deflected at birth. The excessive maternal metabolism at term finds expression in the extra metabolism of the newborn on exposure to a new environment and in the mammary activity of the mother. The

1. Flexion, engagement, and molding.
2. Descent and dilation of the cervix.
3. Internal rotation.
4. Birth of the head by extension.
5. Restitution.
6. External rotation.
7. Birth of the shoulders.
8. Birth of the body of the fetus.

It must be clearly understood that these steps do not occur separately but that one blends into the other so that the entire downward movement of the

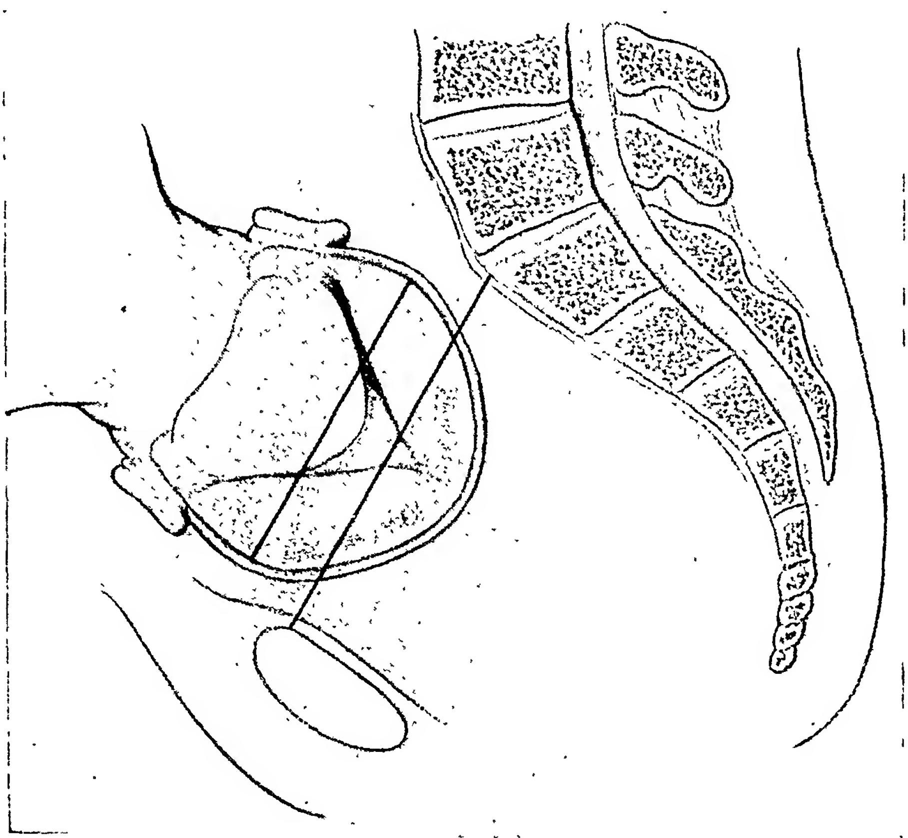

Fig. 383.—The head at the pelvic brim prior to engagement. The sagittal suture occupies the middle of the plane of the superior strait. There is no lateral flexion of the fetal spinal column. Synclitism.

child is a continued and progressive one, each phase of the process merging gradually into the succeeding one.

Engagement is a term used to express the entrance of the presenting part into the pelvis and is said to have occurred when the widest diameter of the flexed fetal head, namely the biparietal, has entered the superior strait. A head is not engaged when its greatest transverse diameter is still above the plane of the superior strait, and if at this time it be freely movable, it is said to be floating.

The phenomenon of engagement usually occurs about three weeks prior to term in primiparae, but only appears in multiparae at the onset of labor.

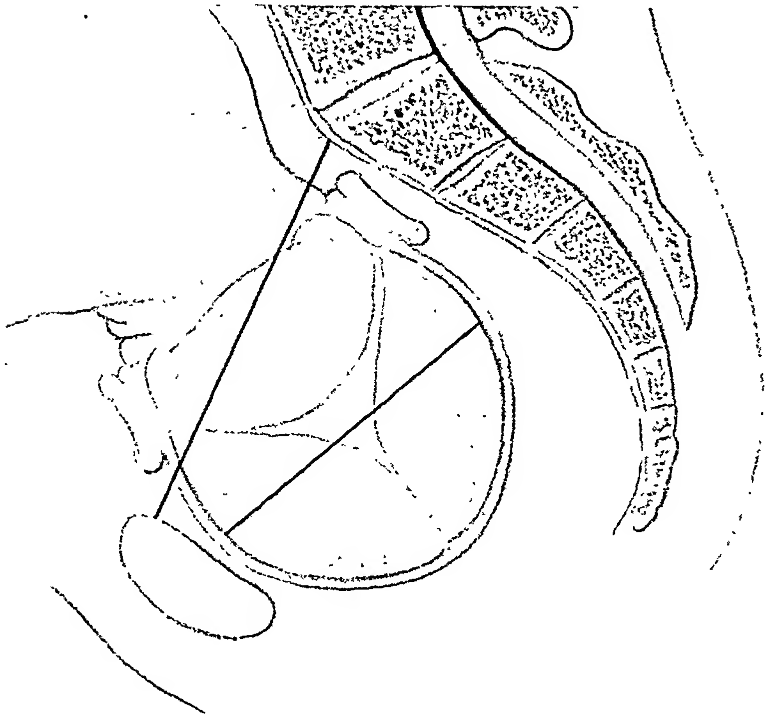

Fig. 385.—Engagement continues, anterior asynclitism increasing.

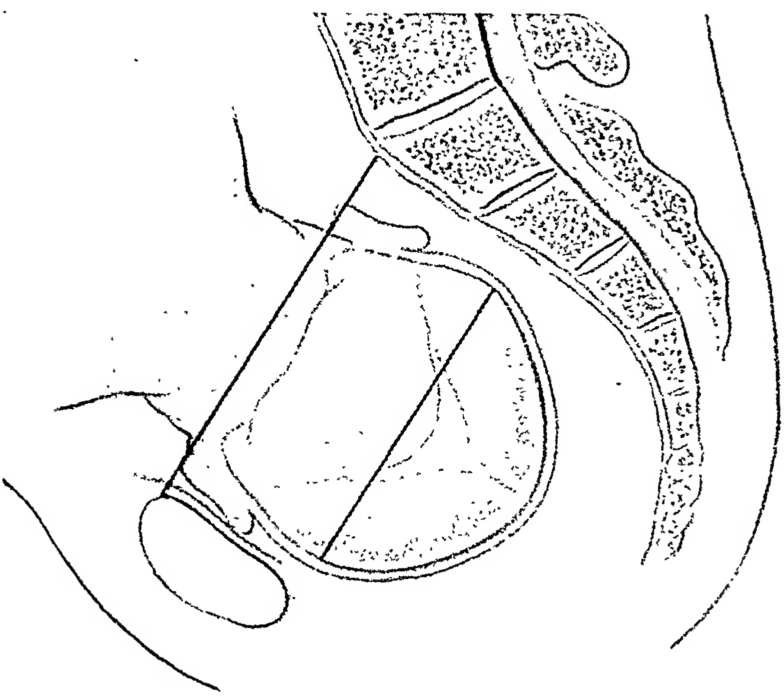

Fig. 386.—Complete engagement. The widest diameter of the head has passed beyond the true conjugate and synclitism is restored.

months of a given pregnancy and then recurrences of increasing severity and longer duration are noted in succeeding gestations. Authorities are agreed that the hygienic conditions attendant upon pregnancy are important factors in the pathogenesis of this obscure condition, which is linked so intimately with hyperparathyroidism in some of its salient features. Scott[15] listed three outstanding predisposing factors from her Indian experience, namely, child marriage, prolonged lactation and purdah. One of the most startling revelations of her study was the protracted period of lactation, which averaged 2.37 years among her osteomalacic subjects. Sixty-nine of 82 individuals in this group developed evidences of the disease during pregnancy or the period of lactation. McCrudden[23] named the following circumstances as contributory: damp buildings, lack of clothing, poor food, repeated pregnancies, prolonged lactation, hard work and lack of care.

The treatment of osteomalacia is primarily hygienic; but since it is a manifestation of calcium deficiency, this element must be supplied in excess. The absorption of calcium is enhanced when given on an empty stomach. The average dose of 1 to 2 Gm. of calcium lactate may be given once or twice each morning before breakfast and spaced as far between meals as possible. The intravenous route is ordinarily not necessary nor is it advisable. Cod liver oil and viosterol have an assured place in all types of calcium deficiency. Heliotherapy and ultraviolet light may also prove helpful. Therapeutic abortion is not indicated; but McCrudden[23] advised roentgen-ray sterilization in view of the hazard of repeated pregnancies. Jägerroos's experiments[26] may explain the escape of the offspring in the majority of instances. He found in dogs that even on a negative maternal balance of phosphorus, nitrogen and salt, the puppies developed at the expense of the bitch.

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tiparae in whom engagement rarely occurs before the first stage of labor begins. In either event, descent once begun continues in association with the other movements of the presenting part, to be described, until delivery occurs.

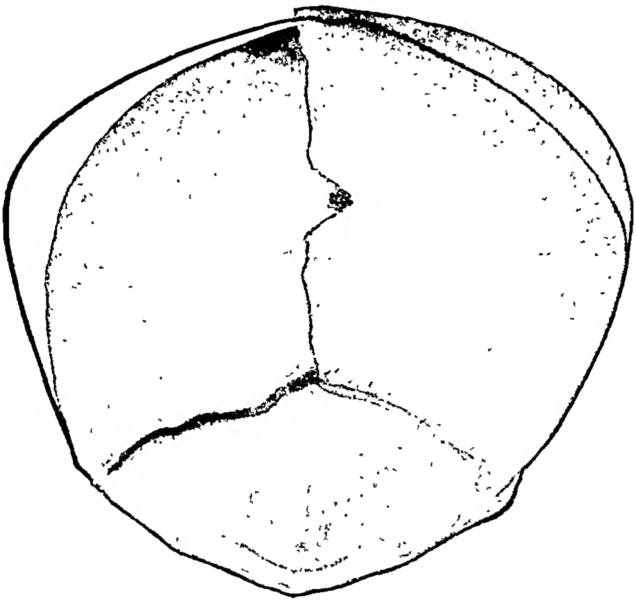

Fig. 390.—Rear view of skull molded in O.L.A. (DeLee, "Principles of Obstetrics.")

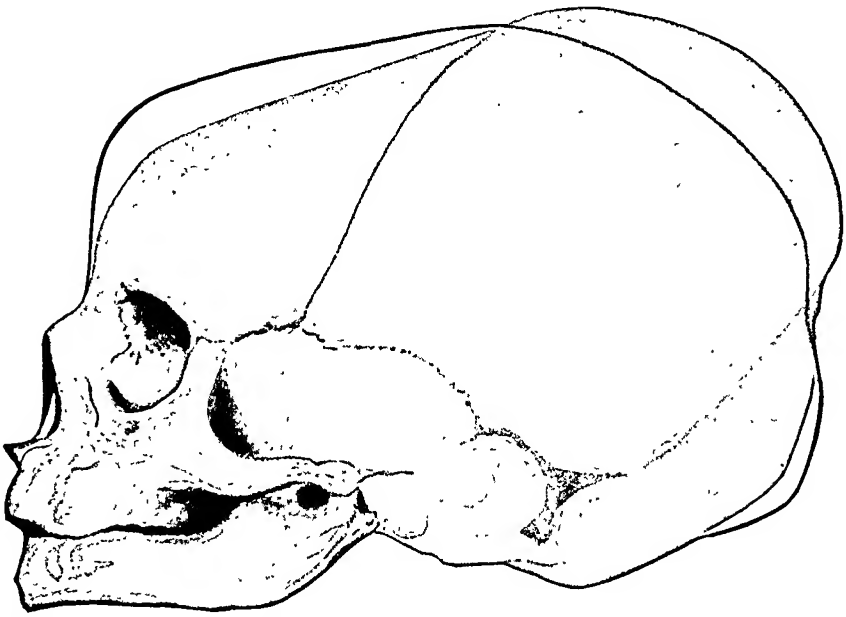

Fig. 391.—Side view of skull molded in O.L.A. (DeLee, "Principles of Obstetrics.")

Descent and Rotation.—Descent is the inevitable resultant of four sets of forces:

1. The intra-uterine fluid pressure of the liquor amnii.
2. Direct pressure of the contracting fundus upon the buttocks of the child.

The introduction of insulin into the therapy of diabetes has entirely revolutionized its management and prognosis. However, even prior to its discovery the keynote of conservatism had been sounded by such leaders as Offergeld,[24] who pointed out that sacrifice of the child by the interruption of pregnancy by no means insures the safety or well-being of the mother. The relationship of pregnancy to the pancreatic disturbance is not constant. At times pregnancy merely complicates or aggravates a preexistent fault in sugar metabolism. Again, diabetes mellitus may, as previously discussed, first make its appearance during the course of pregnancy. The supplemental contribution of fetal insulin may improve the maternal utilization of carbohydrates late in pregnancy; but this is not a constant reaction, nor can it be depended upon. Holzbach[25] remarked the sharp ascent of the maternal blood sugar upon the death of a fetus which had been contributing to the improved combustion of carbohydrates by the mother. He emphasized the probability of the transition from a compensated to a decompensated diabetes under such conditions. Furthermore, according to Kraul,[26] it not infrequently happens that pregnancy complicating diabetes leads to the necessity for a complete revision of diet and insulin dosage with an apparent loss of efficacy in the latter. In other diabetics there may occur a sudden crisis in labor or early in the puerperium. If to these variables be added a knowledge of the reduction of plasma bicarbonate in the latter half of pregnancy, which is compensated for by a reduced CO_2 tension of the blood to maintain a relatively stable acid-base equilibrium,[27] the danger of serious consequences dependent upon the disturbed chemistry of the body will be appreciated.

In general pregnancy should be interdicted in all diabetic women with a familial background of this condition because of the serious prospect of diabetic progeny. Even were this a more remote possibility than experience and study indicate, a strictly eugenic viewpoint would forbid the marriage of, or conception in, diabetic couples. With the exception of such familial diabetics, this fundamental fault in sugar metabolism is per se no longer a contraindication to pregnancy. Insulin has simplified the general problem; but a number of specific questions will arise in the conduct of practically every individual diabetic during pregnancy. For example, the diet will remain the usual thoroughly controlled unit of management; but Stander and Cadden[28] have pointed out the tendency to an increase in the ketone bodies even in normal pregnancies. Hence they favored a diet low in fats and high in carbohydrates, especially if there were any evidences of ketosis in the toxemias of pregnancy. The application of this information to diabetes in pregnancy is inferred rather than established, since there are no corresponding data upon pregnant diabetics; but it would seem justifiable to conclude that the ketogenic-antiketogenic ratio would have to be more rigidly enforced in the presence of pregnancy than in the nonpregnant diabetic. Accordingly it would not appear sound practice to exceed the 1.5 : 1 ratio of available fatty acid to glucose prescribed in usual diabetic diets. Insulin should be adjusted to the need of the individual subject. Since this need will change with the altered carbohydrate metabolism of the mother and the fetus, daily observation should be kept of the urine by the instructed patient and weekly urinalyses and blood sugar determinations should be made by the attending physician. The readjustment of the insulin dosage may then

the outlet develops a nearly circular outline and therefore rotation would not be necessary to secure delivery.

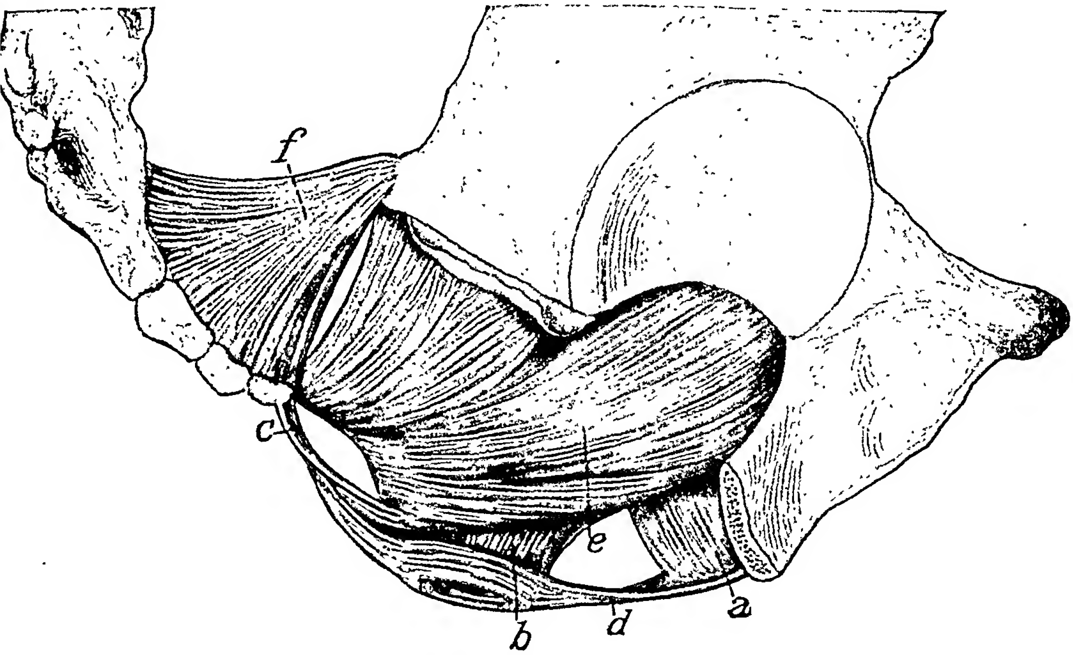

Fig. 397.—Shows levator ani from side—slinglike action. *a*, Vagina; *b*, rectum; *c*, posterior fibers of sphincter; *d*, anterior fibers of sphincter ani; *e*, levator ani, puborectal portion; *f*, musculus ischiococcygeus. (DeLee, "Principles of Obstetrics.")

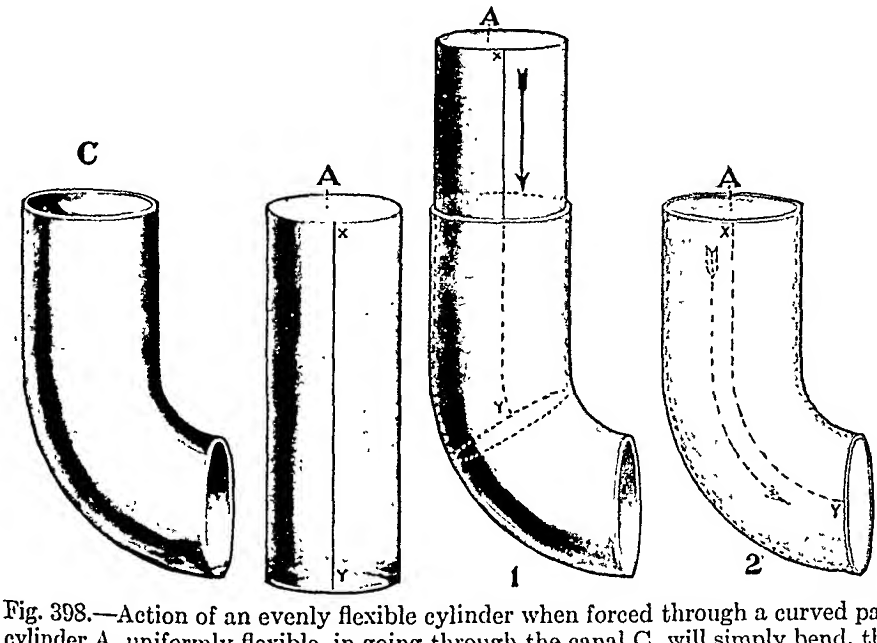

Fig. 398.—Action of an evenly flexible cylinder when forced through a curved passage. The cylinder A, uniformly flexible, in going through the canal C, will simply bend, the line X-Y not changing its relation to C. (DeLee, "Principles of Obstetrics.")

The present tendency is to regard the contour of the musculofascial slings forming the pelvic floor, together with the impetus given by pressure against

planes, until it has rotated through one eighth of a circle and the sagittal suture lies directly anteroposterior. Sellheim's careful studies led him to develop another theory of internal rotation, which unquestionably plays some part in the production of this complicated phenomenon (Figs. 398, 399).

Sellheim regarded the fetal body as a compressed cylinder, flexible in certain limited directions. The trunk cannot move freely anteroposteriorly because of the morphology of the spinal column and the lateral pressure of the arms and legs, but it bends easily from side to side. The head bends freely on the neck from before backward by extension, and it also has a slight

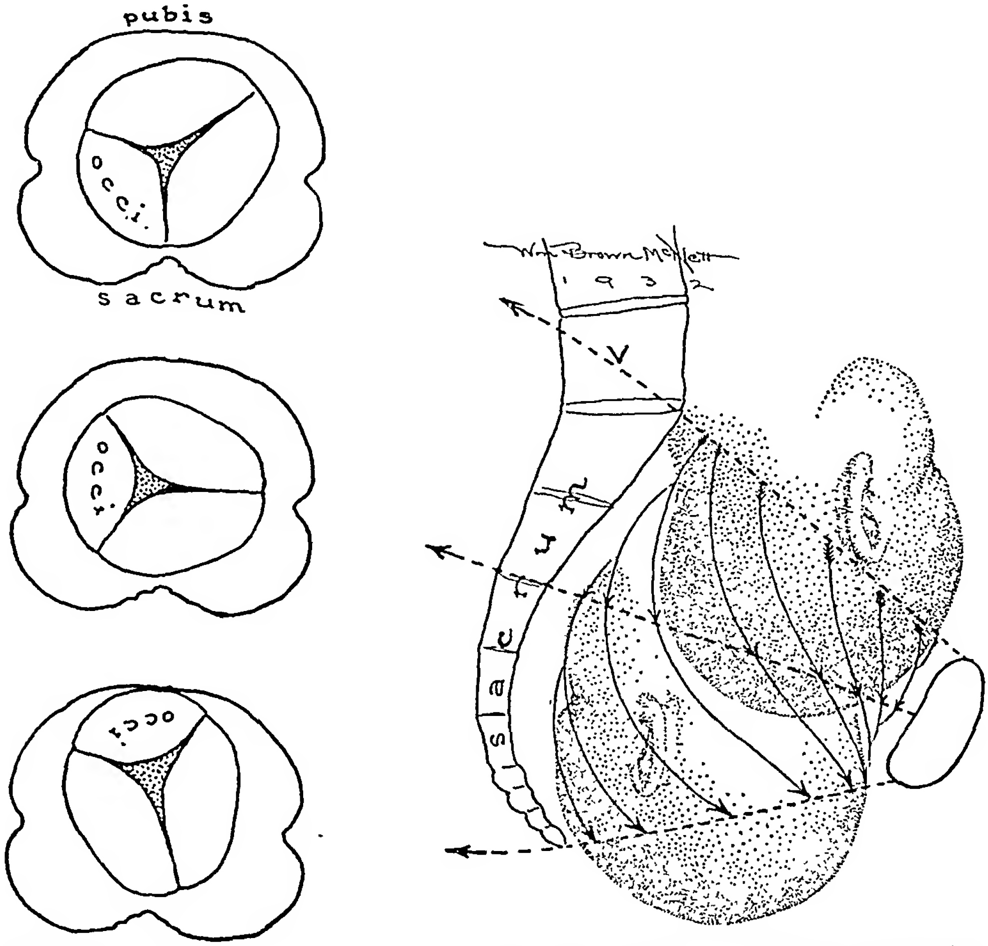

Fig. 400.—The descent and spiral movement of anterior rotation in an R.O.P. presentation.

lateral elasticity. It will be seen that the lateral bending of the trunk and the anteroposterior bending of the head form two lines of direction which cross each other at right angles.

Now if the cylindrical fetus is to pass through the sharply curved birth canal it must rotate on its long axis so as to bring the portion in which bending can most easily occur into line with the axis of the pelvic canal, or until the nape of the neck is adapted to the knee of the canal. Or as Col. Buchanan puts it, "The secret of success is whether you get the pivotal points together." Descent continues during internal rotation, the whole movement being a spiral thrust of the fetus through the pelvic canal.

sition in which it lay before internal rotation occurred. This movement is simply an untwisting of the neck and a return to the normal tonicity of the two sternocleidomastoid muscles, the left side of the neck having been placed in considerable tension during internal rotation.

External Rotation.—This is the movement imparted to the head by the internal rotation of the shoulders, which does not occur synchronously with that of the head. The anterior or right shoulder, being lower than the posterior or left, strikes the pelvic floor first, and in obedience to the same law of rotation that governed the head, the shoulder moves forward, downward and inward, until the bisacromial diameter lies in the anterior posterior axis of the pelvis. The shoulder, moving from right to left, naturally transmits its line of movement to the head, the sagittal suture being always at right angles to the bisacromial line. The head, therefore, turns further toward the mother's right until the face points directly to the right thigh.

Restitution and external rotation frequently take place in such due sequences that they are practically one continuous movement and are quite commonly so described.

Birth of the Shoulders.—Complete rotation of the shoulders having occurred, descent continues with the uterine contractions until the right or anterior shoulder stems under the symphysis and is there delayed. The downward force continuing, the posterior or left shoulder sweeps over the perineum by a process of lateral flexion of the spine, to be delivered, following which the anterior shoulder slips from under the symphysis and is rapidly extruded.

Birth of the Body.—After the expulsion of the shoulders, the fetal body undergoes a marked lateral flexion and rapidly sweeps through the pelvic cavity, its concave side above, the convex below, thus conforming to the curve of the pelvic basin, and is easily and rapidly delivered. The mechanism of right occiput anterior position is identical with that of the left, the words "right" and "left" being simply interchanged.

Mechanism of Labor in Occipitoposterior Positions.—The cause of the greater frequency of primary anterior position of the occiput has already been explained, but in a considerable proportion of cases the occiput enters the pelvic canal posterior to the midtransverse line of the brim.

Many statistics have been collected as to the position in which the head enters the pelvis but as Williams well says, they are of but little value, since the conclusions reached depend so much upon the stage of labor in which the diagnosis was made.

Many observers believe that the head commonly enters the pelvis in the transverse diameter, and only after it has passed the inlet does the occiput turn toward the front or the back, almost always toward the pubis. This does not coincide with the writer's experience; examination of many women at term and in the earliest phases of labor have convinced him that engagement in an oblique diameter is the rule. Very rarely the head may enter the brim with the sagittal suture directly anteroposterior, the occiput either behind, or directly anterior, no further rotation whatever being necessary.

Occipitoposterior positions may be divided, then, into (*a*) primary and (*b*) secondary. The causes of primary occiput positions are naturally those which interfere with the usual relations of the fetus to the pelvic inlet and are generally associated with some deflexion:

verse arrest. Exceptionally, labor proceeds under these conditions, the head being driven through the pelvis and born in the transverse diameter; but much more commonly labor comes to a standstill, the uterus becoming exhausted. Generally, however, after a long first stage, rotation is completed and delivery is accomplished by the usual mechanism of occipito-anterior position.

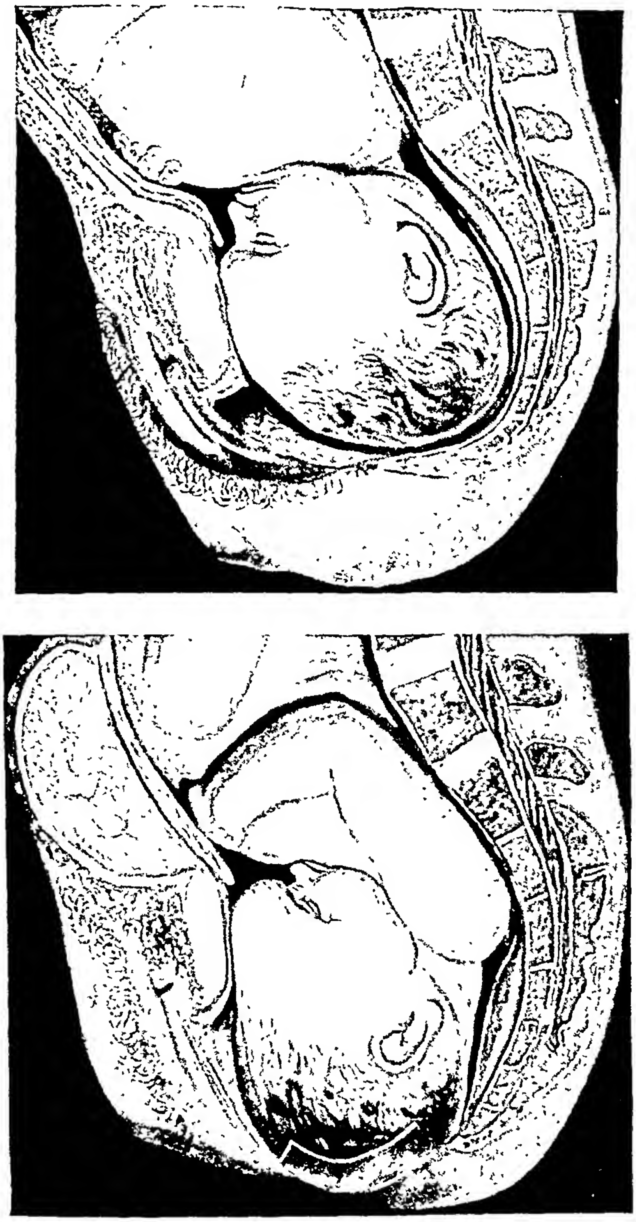

Fig. 402.—Posterior position of a vertex presentation; backward rotation of the occiput. (Hirst, "Text-book of Obstetrics.")

It is a moot point among obstetricians as to just at what plane of the pelvis anterior rotation occurs, some holding that this movement takes place at the upper pelvic planes and is complete when the head reaches the perineum, while others believe that the whole phenomenon of anterior rotation occurs on the pelvic floor. The truth probably lies between the two extremes, in-

placenta, being contracted parallel with its uterine attachment, has become almost twice as thick as at the onset of labor (Fig. 403).

According to the studies of Frankel there is at this time a sharp rush of blood into the placental site, which, acting like a hydraulic wedge, serves to separate further the placenta from the uterine wall. Intra-uterine pressure

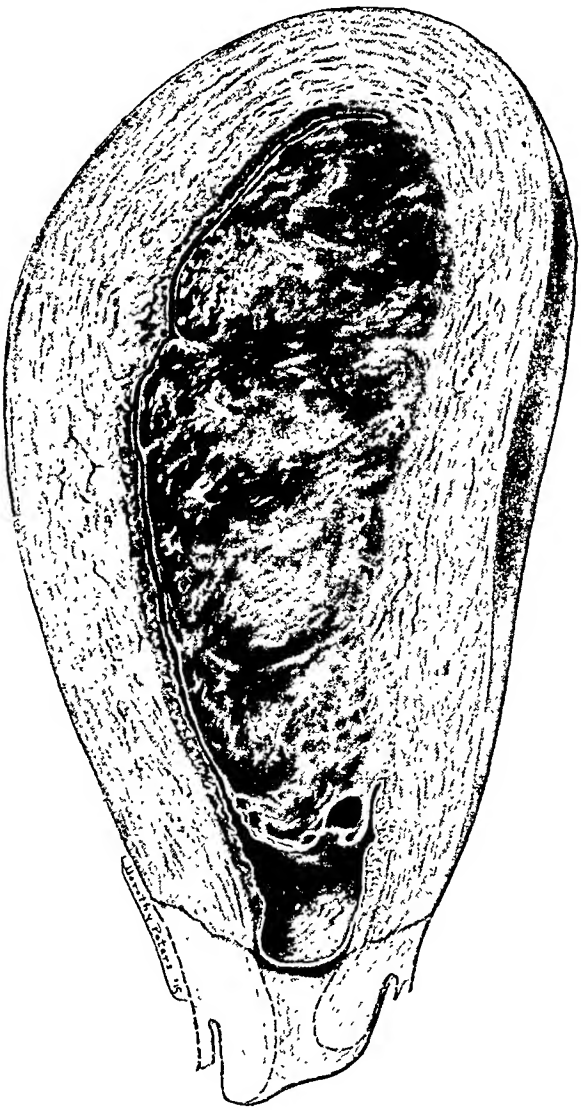

Fig. 403.—Vertical section through uterus removed by supravaginal hysterectomy following cesarean section (× ⅔). Note thickness of muscle walls, increase in thickness of placenta, and decrease in area of its attachment. (Williams, "Obstetrics," D. Appleton and Co., Publishers.)

being relieved, there is nothing to hold the placenta in contact with the uterine wall and separation continues with considerable rapidity. Eventually the placenta becomes so thick and contracted that it can no longer follow the steadily diminishing uterine site, and is peeled off from the uterine wall, the separation being greatly aided by the pressure of the steadily growing retroplacental hematoma. The line of division of the placenta from the uterus is

the internal os and then through the cervical canal, which is already beginning to reform, until the placenta lies in the lower portion of the cervix and the vagina. Now the abdominal muscles contract voluntarily and the placenta escapes from the vulva, the membranes trailing after it, sometimes still adherent to the uterine wall.

Two mechanisms have been described for the expulsion of the uterus. The first is that of Schultze, in which the placenta turns inside out, umbrellawise, the cord and the fetal surface appearing at the cervix and the placental cone, closely apposed to the circumference of the cervix, being pushed through the external os, the membranes following (Figs. 404, 405). The second mechanism of expulsion is that described by Matthews Duncan, in which the separated placenta slides down the uterine wall, its relation remaining unchanged,

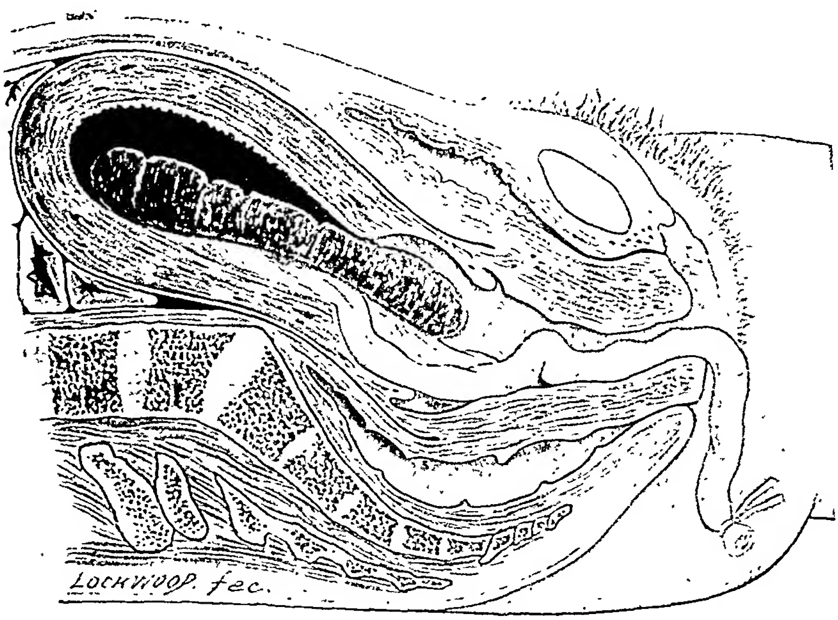

Fig. 406.—Diagram illustrating extrusion of placenta by Duncan's mechanism. (Williams, "Obstetrics," D. Appleton and Co., Publishers.)

until the lower edge appears at the external os from which it is extruded, followed by the rest of the organ (Fig. 406). The placenta usually escapes from the vulva by the Schultze mechanism, but the statements of Warnekros and Weibel are rather convincing as to the method of separation of the organ from the uterine wall. These writers cut the cord immediately after the birth of the child and injected the placenta with a fluid opaque to the x-ray. Immediate roentgenograms showed that the placenta always passed through the lower uterine segment edge first, that separation occurred early, after a very few uterine contractions, and that there was but little evidence of the retroplacental blood clot. They maintained that the placenta always leaves the uterus in this way, and that the mechanisms of Schultze and Duncan only develop in the vagina.

otherwise obscure infection in the patient. The routine use of the face mask and cap by every one in attendance on the parturient is a necessary safeguard against the transmission of infection. The mask should consist of at least four thicknesses of cheesecloth and must cover the nose as well as the mouth to be efficient. Breathing through the nose is normal, and a mask which covers only the mouth lends a false sense of security to the procedure.

The introduction of sterilized rubber gloves has been an incalculable boon to surgery in all its branches but, as with every artificial aid, carries with it the danger of too great a reliance on this aid. Hands not scrupulously cared for, subject to chapping and contamination, are a definite menace, even when rubber gloves are used. Rubber gloves may sustain unnoticed tearing, the hands may perspire, and the mixed infection may find its way into the birth canal. Dry sterilized gloves are preferable to wet gloves. Freshly boiled wet gloves are preferable to none.

Many technics have been described for sterilization of the hands and arms, but none of them has ever succeeded in rendering the skin and nail bed bacteria-free. The objective is removal of surface detritus and bacterial contamination with a final positive chemical attack on the organisms that are still present in the deeper pores and crypts.

No single measure has yet replaced vigorous scrubbing with soap and brush. For beginners a five-minute scrub by the clock, followed by the use of the nail file and another three- to five-minute scrubbing is minimal, and in obstetrics it should be emphasized that the scrubbing, to be efficient, should include the forearm and extend well above the elbow. This scrubbing alone is accepted in some clinics as satisfactory, but in most institutions a chemical follow-up is required. 1 : 5000 bichloride of mercury solution has been in vogue for a long time. Many individuals are sensitive to this chemical and are unable to use it without developing a dermatitis. As a result, the skin becomes less and less amenable to satisfactory scrubbing. The combination of 95 per cent alcohol followed by immersion in bichloride of mercury solution is theoretically more efficient, in that the alcohol dehydrates and removes the remaining surface oil of the skin, thus permitting a deeper penetration of the bichloride of mercury solution.

The bactericidal efficiency of 60 per cent alcohol is about equal to the combination of 95 per cent alcohol followed by bichloride of mercury solution[32] and is, therefore, recommended as a sufficient, satisfactory and nonirritating follow-up to the soap and water scrubbing. The sterile gloves, after being put on, should be rinsed in 1 : 500 bichloride of mercury which in turn is washed off in sterile water, these solutions being kept for successive rinsings of the gloves as they become more or less contaminated by the discharges.

Preparation of the Patient.—At the onset of labor it is highly desirable to empty the rectum. Universal practice includes an enema as soon as the patient is in labor. The enema may be as much as a quart of ordinary soap water. Two purposes are served: the advancing fetal head will not carry out before it the accumulated contents of the rectal ampulla to interfere with maintenance of aseptic technic during the impending delivery; and the enema itself frequently acts as a stimulus to uterine contractions. It should not be administered to the primipara in the second stage of labor, nor to the multipara late in the first stage.

Loss of liquor amnii does not necessarily mean normal rupture of the membranes. The rupture may occur above the level of the fetal head. Later the opening may become plugged as the uterine wall at the site of the hole in the membranes is pulled up by the uterine contractions or by the fetal body, thus restoring the integrity of the membranes. The forewater and membranes in advance of the head remain unaffected. Occasionally only the chorion tears, releasing fluid between the chorion and amnion. This contains no vernix caseosa and is small in quantity.

It should be emphasized that the responsibility for the conduct of labor is placed in the hands of the obstetrician. The decision, therefore, concerning its actual onset must have his interested cooperation. For this reason he, or some one suitably trained to act for him, must be available to the patient at all hours of the day and night.

Determination of the Status at the Onset of Labor.—It is of the utmost importance that the exact status of the patient should be determined as soon as possible after the onset of labor. In all instances blood pressure reading, urinalysis, pulse and temperature should be recorded as a part of the survey of the patient's actual condition at the beginning of labor. A complete and thorough physical examination is essential. Knowledge of the condition of the heart, lungs and other systems is of primary importance, as it may have a direct bearing on the future conduct of the labor. The obstetrical examination should include, in orderly sequence, abdominal examination, rectal examination and then, if it is deemed desirable, an initial vaginal examination.

Abdominal Examination.—In 70 per cent of normal primiparae the fundus uteri drops from 3 to 6 cm. below the ensiform process in the last weeks of pregnancy. This "lightening" is due to the steady resistance which the comparatively tense abdominal walls have offered to the encroachment of the uterine bulk. The flanks contain only abdominal contents, and on lateral palpation of the uterus the small parts and fetal back can usually be located on opposite sides. The level of the fundus uteri drops as described when the fetal head descends into the true pelvis to such a level that its widest transverse diameter (the biparietal) has passed the superior strait or pelvic inlet. This level, known as *engagement*, is usually determinable by abdominal examination, employing Leopold's fourth maneuver.[24] With this degree of descent that portion of the head which is still palpable from the abdomen converges under the examining hands. In the multipara and the primipara in whom engagement has not yet occurred, the sides of the head diverge under the examining hands. The location of the anterior shoulder is a further aid toward the diagnosis of fetal position. Auscultation should be employed, not merely to find the fetal heart tones and determine their rate, quality, and rhythm, but to ascertain the point of maximum intensity as an additional aid toward the diagnosis of position. It is entirely possible at this time to palpate one, and usually both, round ligaments. Their direction serves to locate the placenta in 80 per cent of all patients. If they are found to diverge toward their uterine insertions, an anterior implantation of the placenta may be assumed. If they ascend parallel or converge, it may be assumed that the placental site is lateral or posterior. The round ligaments at this time, though moderately tense, are never taut or sensitive.

has its onset in the course of pregnancy or the puerperium. In his series of 240 cases of tuberculosis in women of the childbearing period, 151 (63 per cent) gave the history of the disease appearing first in pregnancy or in the puerperium. One hundred and three of this group of tuberculous individuals experienced their first symptom in the puerperium. Of this series of 151 patients, 36 were dead at the time of the report. Activation of a latent process seemed almost inevitable. Accordingly Trembley advised therapeutic abortion in all tuberculous women, unless the following conditions obtained: Inactivity of the lesion for a year, terminal stages of the disease and serious dissemination. Abortion before the end of the third month of pregnancy in his experience excited no adverse reaction. Norris and Landis[10] emphasized the serious prognostic significance of tuberculous laryngitis occurring in the course of pregnancy. In the presence of this complication or in active and progressive lesions they advised therapeutic abortion before the fifth month of pregnancy. In a review of this question Funk[11] quoted from various sources figures of 25 to 70 per cent of tuberculous women showing symptoms of activation in pregnancy. His attitude toward intervention was very conservative and sound. In the first place the course of an active minimal lesion should be closely observed before evacuation of the uterus is advised in the early months of pregnancy. If progression of the lesion be observed, abortion is indicated. Late in pregnancy, even in the presence of activity, intervention is contraindicated. The German viewpoint may be summarized in the advice of Zweifel[12] to abort early when necessary. The lay quotation, "Die Schwangerschaft mehrt; das Wochenbett zehrt," well expresses the threat of the puerperium; and Funk[11] has clearly outlined the illusionary improvement of early pregnancy which not uncommonly gives way to a sharp decline later in pregnancy or during the puerperium. Peham[13] warned that interruption in the second half of pregnancy, and especially in the last lunar month, is as dangerous as delivery at term. In an excellent analysis of the situation Pankow[14] reviewed the statistics and pointed out the need for a better organization of the information on the subject, in view of the unfavorable outlook in 75 per cent of cases of manifest tuberculosis.

Valuable as have been the several isolated contributions to the general knowledge of this question, the most fruitful plan of attack directed toward its solution has been advanced by Robinson.[15] Two hundred answers to a questionnaire evolved by him were received from Great Britain, Ireland, South Africa, Switzerland, France, Canada, United States, Australia, and China. One hundred and forty-six of 167 replies supported the position that childbearing, especially if repeated frequently or at short intervals, has a definite effect in developing a latent lesion. Late pregnancy and the puerperium were the favored times for activation in the opinion of the majority. Only a minority (28 of 181) thought that pregnancy was ever beneficial to the tuberculous woman. The induction of abortion was favored in 122 of 202 answers. The indications were not clearly defined but included the early active lesion and the reactivation of a quiescent lesion early in pregnancy. Sterilization was not favored by a majority; but in the negative responses contraception was advised by a goodly proportion.

If the validity of all of the advanced evidence be admitted, it will be perceived that the problem within certain limits is still an individual one. In no other condition is the physician's judgment and responsibility more

since there is no increased danger of infection if carefully and properly done.

The cervix of the primipara at the onset of labor shows marked variations. Usually some effacement has already occurred, the cervix being 2 cm. or less in length. Frequently effacement may be entirely complete with an obliteration of the cervico-uterine angle on the vaginal surface.

The fetal head occupies the lower uterine segment, the internal os has been obliterated, and the tissues of the cervix have been merged into the wall of the lower uterine segment. Usually, however, the external os remains undilated or, at most, dilated to 2 cm.

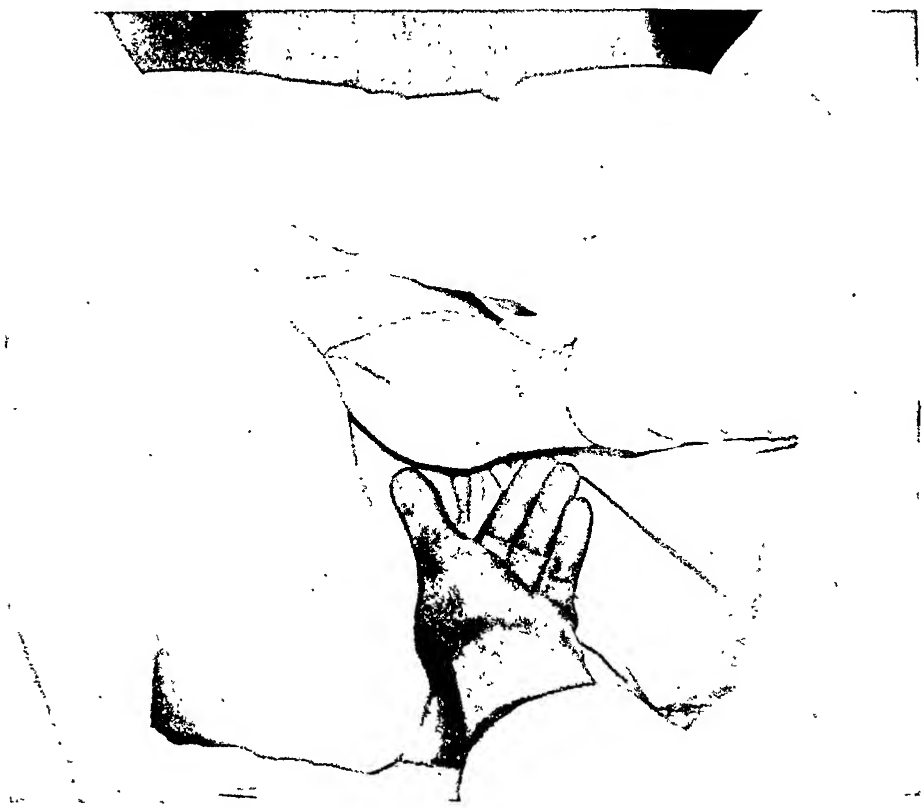

Fig. 411.—The Mueller maneuver. The pelvic level to which the fetal head can descend under suprapubic pressure may be determined by either vaginal or rectal examination.

In the multipara, on the other hand, the external os is frequently found gaping 2 or even 3 cm., while the cervix is still only half effaced.

In the opinion of the author effacement, that is, obliteration of an identifiable cervical structure, is always completed before dilatation of the external os has exceeded 4 cm. The edge of the external os may be thick or thin, but the canal no longer exists, the cervix no longer hangs down teatlike from the lower uterine segment and the cervico-uterine angle can no longer be felt on the vaginal surface.

The presenting part, the head, in 70 per cent of normal primiparae, has descended into the true pelvis, as may be determined abdominally, and its most dependent part has reached the level of the spines of the ischium.

in engagement, as the lax abdominal walls permit the uterus to bulge anteriorly with the growth of the fetus and lightening is less likely to occur. Engagement usually occurs after labor has definitely begun, but may be delayed until near the end of the first stage. In these patients rupture of the membranes may be followed by an advance of the head from inlet level to visibility in one or two pains.

The technic of rectal examination requires rubber gloves which preferably are kept for this purpose only. The index finger is lubricated with any form of water-soluble jelly (tragacanth) and introduced pointed slightly anterior, in order to conform with the direction of the anal canal at the level of the

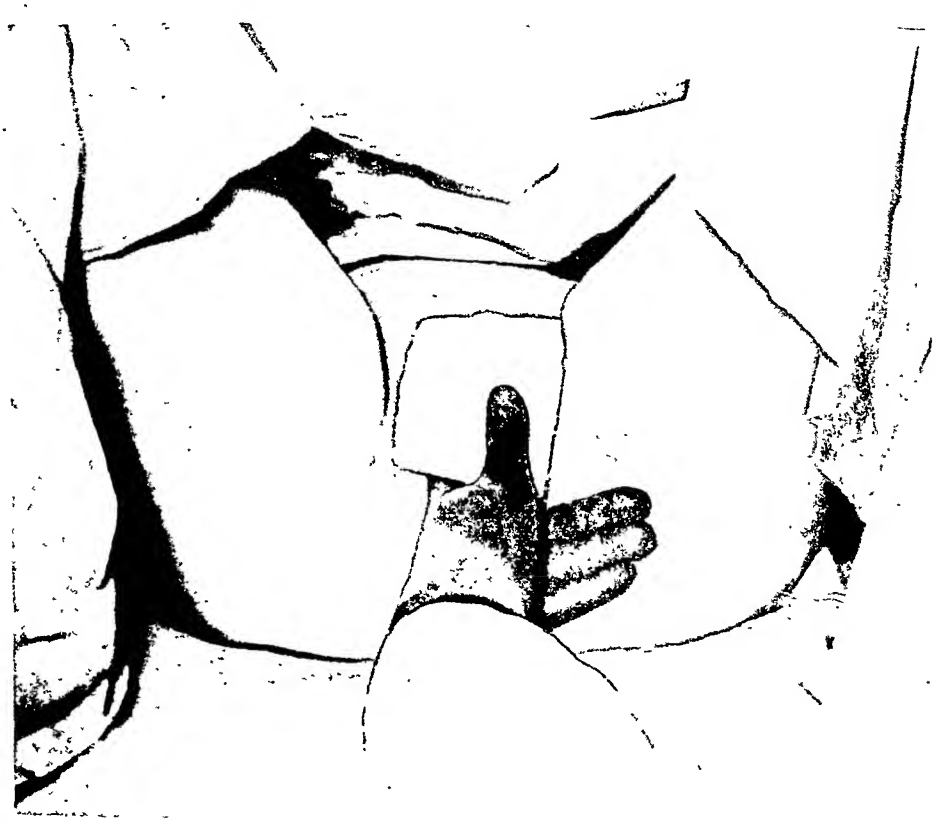

Fig. 413.—Technic of rectal examination. The finger in position. Genitalia protected by sterile gauze pad.

sphincter. The thumb should point forward resting against the external genitalia, which are protected by a pad of sterile gauze. At the time of introduction of the finger the patient is instructed to strain. This relaxes the sphincter and permits of an easier introduction of the finger. The hand can be carried against the perineal body to almost any depth without causing the patient any discomfort, thus permitting correspondingly increased penetration for the examining finger. On withdrawal of the gloved finger the genital pad controlled by the thumb is brought down over the perineal body and is used for cleansing the anal region in a single downward sweep. In the presence of painful hemorrhoids pressure against the perineum must be avoided.

The technic of vaginal examination should be identical with the technic carried out at the time of delivery in so far as concerns preparation of the patient and examiner. In hospital practice it is usual for each clinic to have a fixed and precise method of preparation both for examination and delivery. Since home obstetrics at its best should be regarded as second to properly conducted institutional practice, the technic of examination and delivery in the home should follow as closely as possible the practice of that institution in which the accoucheur has had his or her best training.

The initial vaginal examination should be regarded as an essential in every teaching institution, not merely to establish with accuracy the true "status praesens" of the newly admitted patient in labor, but to give the younger members of the profession opportunity to familiarize themselves with the conditions as they exist, so that examinations per rectum will be made with a more intelligent basis for comparison.

Preparation of the Patient for Vaginal Examination.—The patient has already had an enema, a shower or sponge bath and the genitalia and abdomen have been shaved. Here, as in hand preparation, the basis is a soap and water scrubbing with squares of sterile linen cloth. The nurse or assistant who is to prepare the patient must first scrub her own hands by the technic already described and then put on sterile gloves. The patient is placed on a douche pan with the knees widely separated. The skin of the genitalia and abdomen are scrubbed first, then the medial surfaces of the thighs and lastly the anal region. One cloth wrapped around the fingers is used to cleanse the genitalia. Special attention should be paid to the stripping back of the frenulum and the removal of such smegma as may have accumulated around the base of the clitoris and in the folds of the labia minora. A second cloth with green soap and water is now used on the abdomen and inner surface of the thighs from the umbilicus downward with crosswise strokes. The anal region is cleansed last. Accumulated soap and water is now removed by pouring sterile water from a pitcher held above the abdomen, the labia being held together during this part of the cleansing so that the washings will not find their way into the vaginal canal, a possibility especially in multiparae.

The use of chemicals in the further preparation of the patient has had a very long trial in the clinics of the world. The present-day favorites are tincture of iodine application and its subsequent removal by alcohol, or repeated painting or spraying of the skin with 4 per cent mercurochrome solution in equal parts of acetone and alcohol.

An additional step in the attempt to achieve an aseptic field for vaginal delivery has been the repeated bathing or swabbing of the entire vaginal tube with 4 per cent aqueous solution of mercurochrome. Published statistics[25, 26] would seem to indicate that this latter procedure has lowered puerperal morbidity by 40 per cent.

Experience has justified the conclusion that there is not sufficient protection offered by tincture of iodine to warrant subjecting the patient to the occurrence of a more or less severe dermatitis, and that the 4 per cent mercurochrome application to the external skin serves no useful purpose. Moreover, the vaginal tube in the days preceding the onset of labor has a definitely bactericidal effect on pathogenic organisms. The attempt to improve upon this protection by the invasion of the vagina for the necessary carrying out

source of chilling, of which many patients complain. The style of sterile draping is less material than that the draping shall be so contrived as to keep the lower extremities entirely enveloped, the lower abdomen and flanks protected and the genitalia freely exposed. Heavy sterile leggings which reach halfway up the thighs and which are tied in place just above the knee, together with a sheet which is large enough to complete the covering of the pelvis and lower trunk, are satisfactory. This permits of ready removal and replacement of the sheet in case it becomes contaminated. In addition the patient has been placed on a sterile square of absorbent padding immediately after the removal of the douche pan.

Technic of Vaginal Examination.—In the examination itself the patient is on her back, the thighs and legs flexed, knees widely separated, and feet resting on the bed; the examiner separates the labia widely from above,

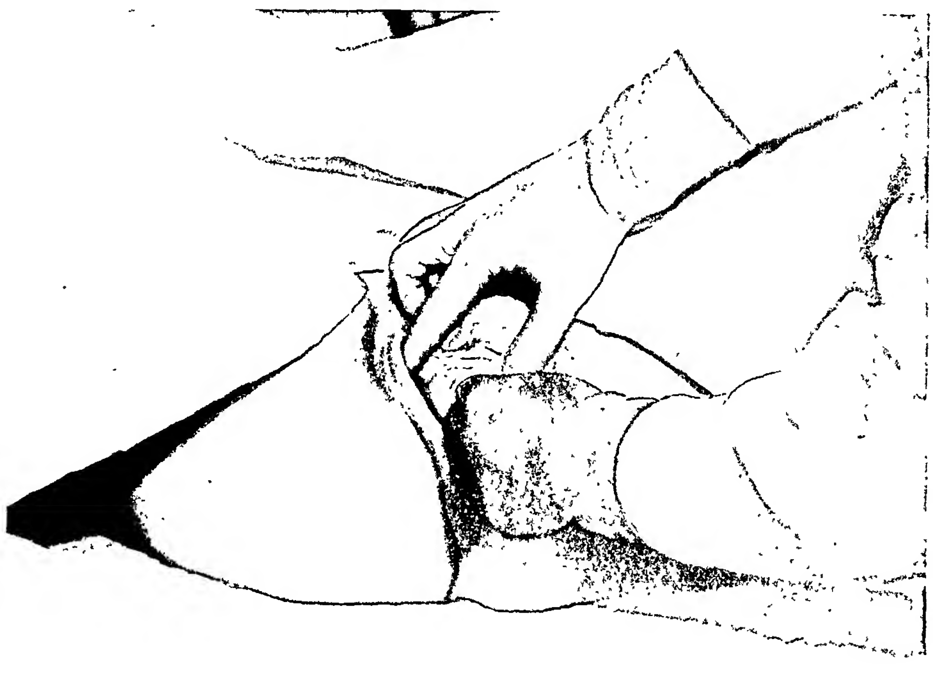

Fig. 417.—Technic of vaginal examination. The physician gowned and gloved as for delivery separates the labia widely from above and introduces one or two fingers into the vagina.

and introduces one or two fingers of the other hand. The fingers should be inserted along the posterior wall of the vagina rather than from above downward, as many women experience distinct discomfort from any pressure against the structures external to and just under the symphysis. Moreover, the perineal body permits of posterior displacement and easier ingress for two fingers by this method of approach, a consideration in the examination of primiparae. The elbow should rest on the bed in line with the vaginal axis, and the forearm, hand, and finger should form a straight line. The fingers now locate and confirm the state of the cervix as it was found on rectal examination and, in addition, determine the size of the external os.

Vaginal examination permits of a more detailed study of the fetal head, its position, attitude, level, degree of ossification, molding, and relation

and sometimes bulging. Inspection of the external genitalia reveals gaping of the labia, more or less pouting of the anterior and posterior vaginal walls just within the fourchette, and a conversion of the hymen into multiple tags, known as the *carunculae myrtiformes*. Moreover, there may be scars of the perineal skin from the fourchette posteriorly, indicating previous lacerations or episiotomy. The cervix of the multipara is patulous at the external os, usually admitting a finger, while the internal os may still remain undilated.

Condition of the Fetus.—Throughout labor the most reliable index of the condition of the fetus is obtained by frequent observation of the rate, quality, and rhythm of the fetal heart tones. For this purpose the naked ear may be used, but the binaural stethoscope pressed firmly against the abdomen affords the best source of information.* The Hillis head stethoscope* enables the accoucheur to listen to heart tones after he is scrubbed, an important consideration if no other capable person is available for this purpose.

The normal rate may range from 120 to 160 beats per minute, 140 to 144 being the most common. The rate is usually quite constant for any given fetus, though variations of 10 to 20 beats are frequent as labor advances. A drop below 100 or rise above 160 usually indicates some interference with the fetal circulation. This if confirmed and continued is the forerunner of fetal asphyxia. Immediate operative delivery may become necessary in the interest of the fetus but only if this is consistent with safety for the parturient.

Too much emphasis cannot be laid on the importance of frequent determination of the heart tones to assure the accoucheur that the fetal circulation remains intact. Half hourly readings in early labor, fifteen-minute readings as labor becomes more advanced, five-minute readings in the expulsive stage, and even determination between contractions are essential for such assurance. Failure to observe this elementary precaution has resulted only too often in the careful and even skillful delivery of a dead fetus whose life might have been saved if the impending asphyxia had been recognized.

As the contractions increase in severity, duration and frequency their effect on the oxygenation of the fetus, as shown by variations in the fetal heart tones, becomes noticeable. At the beginning of a contraction the heart tones become faster, at its height they become appreciably slower or cannot be heard, then as the uterus relaxes they accelerate to a rate somewhat greater than normal for that fetus before resuming their normal rhythm. For this reason it is essential that heart tone readings be taken while the uterus is in a state of relaxation, preferably halfway between contractions. Failure to observe this practice has frequently occasioned the false assumption in a given case that the heart tones have become dangerously slow or unduly rapid. This in turn has precipitated a premature operative interference with the otherwise normal progress of labor to the definite detriment of both child and mother.

CONDUCT OF THE FIRST STAGE OF LABOR

This period, which involves effacement and dilatation of the cervix and so prepares the birth canal for the expulsion of the fetus, averages almost

* Thus far no satisfactory phonendoscope with audio amplification for continuous audibility of the heart tones has been devised because of the presence of many secondary sounds occurring in the abdomen.

Nourishment during the course of labor must be adjusted to the individual. In no instance after labor has actually begun should the patient be permitted

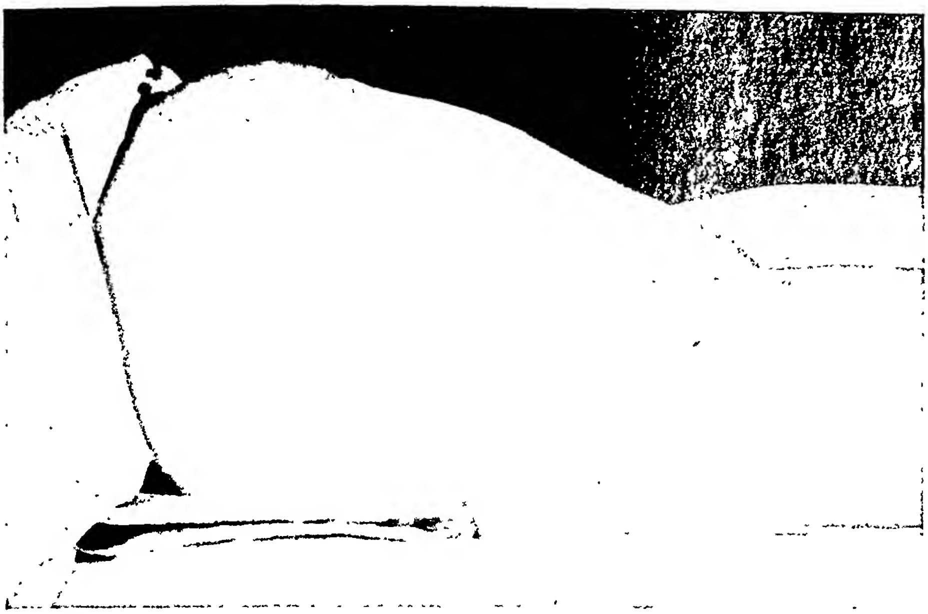

Fig. 419.—Contour of the lower abdomen without bladder distention.

to indulge in heavy solid food, since nausea and even vomiting occur not infrequently in the course of labor. Moreover, if anesthesia is required or desired, the stomach should not be burdened with a partially digested meal.

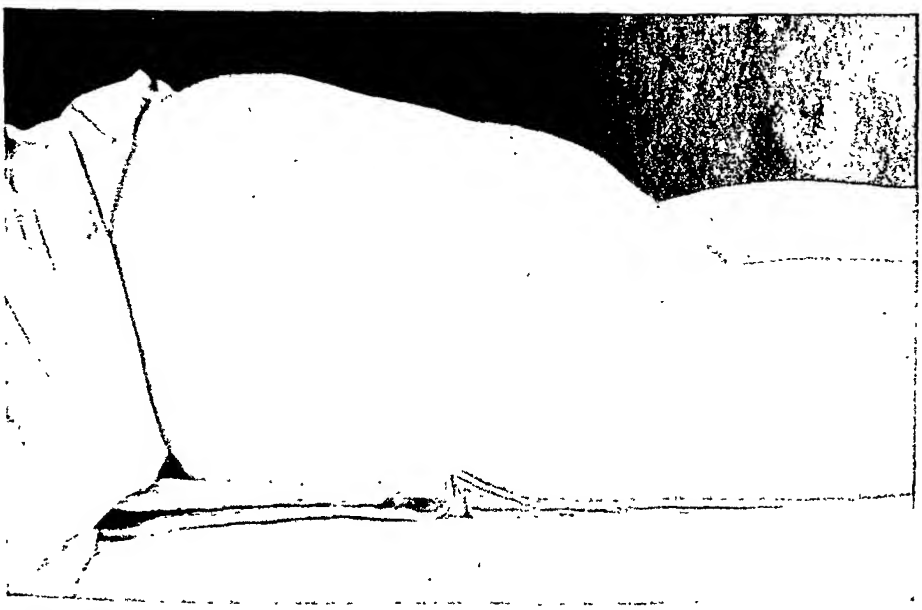

Fig. 420.—Contour of the lower abdomen in the presence of a distended bladder.

On the other hand, it is essential to encourage the patient to take fluids freely, especially in the early stages of labor. This will counteract dehydration

quently requires a prolonged period of resuscitation, and that there is a higher fetal mortality.

Bromides are of little value except in massive doses per rectum and then only in the early hours of labor when sleep is not the first requirement. Moreover, there are occasional patients who react violently with an ulcerative dermatitis to this particular drug. Infiltration anesthesia of the cervix and perineal body has not won general approbation and is not to be recommended.

Spinal anesthesia in normal labor[19, 23] undoubtedly aids in the effacement and dilatation of the cervix, and relaxation of the pelvic musculature surrounding the birth canal. However, it carries with it the risks that are inherent in any form of spinal anesthesia and an increased incidence of postpartum hemorrhage. Fetal asphyxia occurs more often, necessitating rapid operative delivery. Spinal anesthesia, therefore, is likewise not to be recommended.

The Gwathmey oil and ether rectal anesthesia[18] is an excellent method for the administration of ether, particularly when the respiratory system is the seat of any active inflammatory process. A specific objection to this method of anesthesia is the occasional occurrence of ulceration of the rectal mucosa and even perforation when used unskilfully or in improper mixtures. A more serious objection to this method, to magnesium sulphate, and to the barbituric acid derivatives is the fact that their action, once obtained, persists over varying periods of time, and that they are not removable anesthetics. Once administered, their effect continues until the total quantity used has been neutralized. Their anesthetic effects cannot be terminated to meet changes in the maternal or fetal status.

In the second stage it is highly desirable that the patient be encouraged to use her voluntary musculature to supplement the action of the uterine contractions. There is no single measure which affords the patient more actual relief from the recurring pain of second-stage contractions than the privilege of coordinating her bearing-down efforts with these contractions.

The ideal analgesic and anesthetic for the second-stage pains is a mixture of ethylene and oxygen. There is no cyanosis even in high concentrations, no risk of fetal asphyxia, and usually no vomiting. The outstanding objection to this mixture is its explosiveness. This quality has kept the method from widespread popularity in hospitals. Elaborate systems of grounding the machine, patient, and table have been devised, however, to prevent the accumulation of static electricity which may cause an explosion. The problem should be comparatively simple, but may require the cooperation of a physicist for the original installation.

In this connection it should be recognized that there is an explosive risk connected with ether and nitrous oxide as well, the degree varying with the concentration of the gas and the proximity of any ignition source.

Nitrous oxide and oxygen have always an asphyxiation effect, but in low concentration serve very well as an analgesic, without undue cyanosis. This anesthesia is available in portable machines.

Both ethylene and nitrous oxide can be supplemented by the introduction of small amounts of ether, if necessary, for terminal anesthesia.

The prolonged administration of ether, even when given by the drop method on an open mask and interrupted with each resting period between

breath as long as possible while continuing to bear down. The duration of an average second-stage pain is equivalent to three such prolonged bearing-down efforts. If now the patient and anesthetist will cooperate so that at the very beginning of each pain the patient receives a few breaths of the available analgesia, she can then proceed with her three prolonged, expulsive efforts, each preceded by a fresh breath of analgesic, and so get the maximum result and adequate analgesia.

It is at this time that zealous observation of the fetal heart tones, as already described, becomes increasingly imperative. The bladder, likewise, should be emptied if distended. The membranes, if they have remained intact after complete dilatation, or if they have bulged through a partially dilated cervix, are no longer fulfilling their proper purpose in the hydrostatic efface-

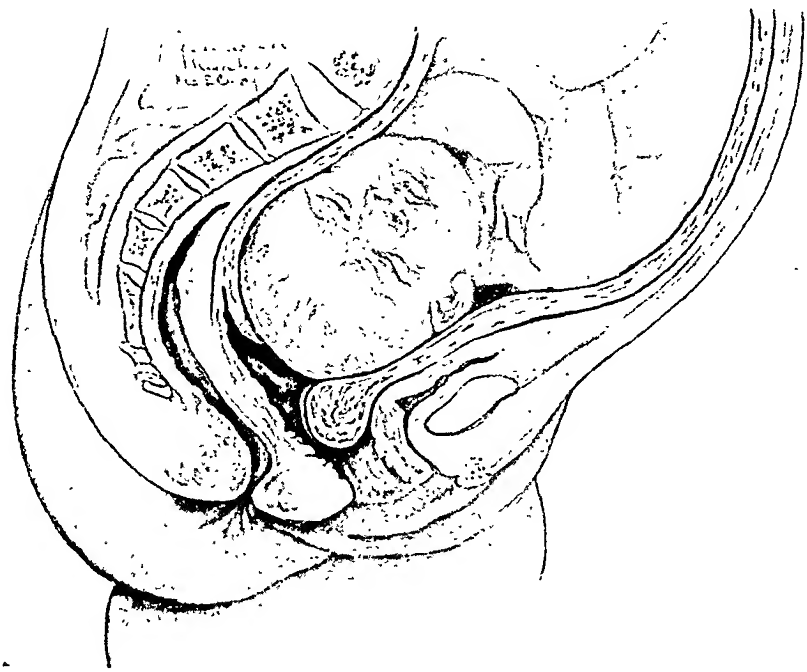

Fig. 421.—Incarceration of the anterior lip of the cervix. Note how the swollen and edematous anterior lip of the cervix, caught between the symphysis and the fetal head, acts as a barrier to the descent of the fetal head.

ment and dilatation act and should be artificially ruptured. This may be done with the fingers or with any instrument, preferably a blunt one, under the guidance of two fingers in the vagina and with all the precautions of asepsis which belong to a vaginal examination. The actual rupture should be done when the uterus is relaxed rather than at the time of a contraction. The tear should be enlarged with the fingers to insure the removal of the membranes from the presenting part of the head.

Artificial rupture of the membranes is justifiable if there is an obvious hydramnion. This condition, by overdistending the uterus, lowers its contractile efficiency and results in a prolonged first stage. The procedure should not be carried out until the cervix is more than half dilated. At the moment of rupture, the head should be crowded into the inlet if it is not

It is likewise true that in the apparently uninjured primipara a submucous trauma of the anterior pillars of the vulvar outlet, both fascial and muscular, may have occurred. It is well known that the appearance of the external genitalia in the parous woman is different from that of the nulliparous woman. The labia gape and through the introitus a slight pouting of anterior and posterior vaginal walls is visible. Who shall say that this altered state of the introitus of the parous woman is not normal? Only if the injuries have so undermined the efficiency of the perineal wedge at any level, resulting in an appreciable rectocele on bearing down with definite impairment of the levator muscle, is it proper to consider that the parturient was materially damaged.

The action and integrity of the levator muscle can be readily tested, preferably three to six months after delivery, by inserting a finger into the vagina palm downward against the posterior vaginal wall. The patient is then tapped several times on the buttock just opposite the anus and told to pull in or pull up at this point, or to squeeze the examining finger. Immediately the levator is felt to contract under the vaginal finger which can then be shifted to each side, thus surveying the entire sheet of levator fibers. If this test is carried out on the nullipara, the levator will be revealed as a continuous and resistant surface extending from just within the introitus for about 8 cm. along the vagina and from one lateral pelvic insertion to the other.

Injury and impairment after childbirth are equally readily revealed. The broad sheet of muscle may be only a narrow band on either or both sides. There may be a broad gap in the otherwise intact sling, or there may be no defect except just within the introitus. This is the least important of the injuries.

The other gynecological types of pathology so frequently found, such as herniation of the bladder through the anterior fascial structures (cystocele), the laceration of the cervix, the descent of the cervix to a pathologic level either by elongation or with the corpus, the scars of the broad ligaments, the malpositions of the uterus, may not be properly charged to treatment or lack of treatment of the perineal body.

With the foregoing brief exposition of the factors involved in the treatment of the perineal body, a procedure may be outlined for the conduct of the terminal act of the second stage of labor, the delivery.

Delivery of the Fetus.—There is a middle ground which requires, as is always the case in disputed procedures in any branch of medicine or surgery, the use of judgment on the part of the responsible attendant. In forming this judgment, it is necessary by examination to know of the presence or absence of any of the disturbing factors previously described. Having determined by the downward pressure of two fingers placed against the posterior wall of the vagina that the perineal body and introitus have their normal elasticity and that there is room between the descending pubic rami for the normally advancing head, delivery should be undertaken without any surgical attack on the perineal body. As the head slowly advances with each contraction, receding between contractions, it distends the vulvar outlet until the parietal bosses, representing the greatest transverse diameter of the head, have passed the pubic rami. After this the head no longer recedes. Meanwhile the perineal body is increasingly distended and elongated;

has its onset in the course of pregnancy or the puerperium. In his series of 240 cases of tuberculosis in women of the childbearing period, 151 (63 per cent) gave the history of the disease appearing first in pregnancy or in the puerperium. One hundred and three of this group of tuberculous individuals experienced their first symptom in the puerperium. Of this series of 151 patients, 36 were dead at the time of the report. Activation of a latent process seemed almost inevitable. Accordingly Trembley advised therapeutic abortion in all tuberculous women, unless the following conditions obtained: Inactivity of the lesion for a year, terminal stages of the disease and serious dissemination. Abortion before the end of the third month of pregnancy in his experience excited no adverse reaction. Norris and Landis[10] emphasized the serious prognostic significance of tuberculous laryngitis occurring in the course of pregnancy. In the presence of this complication or in active and progressive lesions they advised therapeutic abortion before the fifth month of pregnancy. In a review of this question Funk[11] quoted from various sources figures of 25 to 70 per cent of tuberculous women showing symptoms of activation in pregnancy. His attitude toward intervention was very conservative and sound. In the first place the course of an active minimal lesion should be closely observed before evacuation of the uterus is advised in the early months of pregnancy. If progression of the lesion be observed, abortion is indicated. Late in pregnancy, even in the presence of activity, intervention is contraindicated. The German viewpoint may be summarized in the advice of Zweifel[12] to abort early when necessary. The lay quotation, "Die Schwangerschaft mehrt; das Wochenbett zehrt," well expresses the threat of the puerperium; and Funk[11] has clearly outlined the illusionary improvement of early pregnancy which not uncommonly gives way to a sharp decline later in pregnancy or during the puerperium. Peham[13] warned that interruption in the second half of pregnancy, and especially in the last lunar month, is as dangerous as delivery at term. In an excellent analysis of the situation Pankow[14] reviewed the statistics and pointed out the need for a better organization of the information on the subject, in view of the unfavorable outlook in 75 per cent of cases of manifest tuberculosis.

Valuable as have been the several isolated contributions to the general knowledge of this question, the most fruitful plan of attack directed toward its solution has been advanced by Robinson.[15] Two hundred answers to a questionnaire evolved by him were received from Great Britain, Ireland, South Africa, Switzerland, France, Canada, United States, Australia, and China. One hundred and forty-six of 167 replies supported the position that childbearing, especially if repeated frequently or at short intervals, has a definite effect in developing a latent lesion. Late pregnancy and the puerperium were the favored times for activation in the opinion of the majority. Only a minority (28 of 181) thought that pregnancy was ever beneficial to the tuberculous woman. The induction of abortion was favored in 122 of 202 answers. The indications were not clearly defined but included the early active lesion and the reactivation of a quiescent lesion early in pregnancy. Sterilization was not favored by a majority; but in the negative responses contraception was advised by a goodly proportion.

If the validity of all of the advanced evidence be admitted, it will be perceived that the problem within certain limits is still an individual one. In no other condition is the physician's judgment and responsibility more

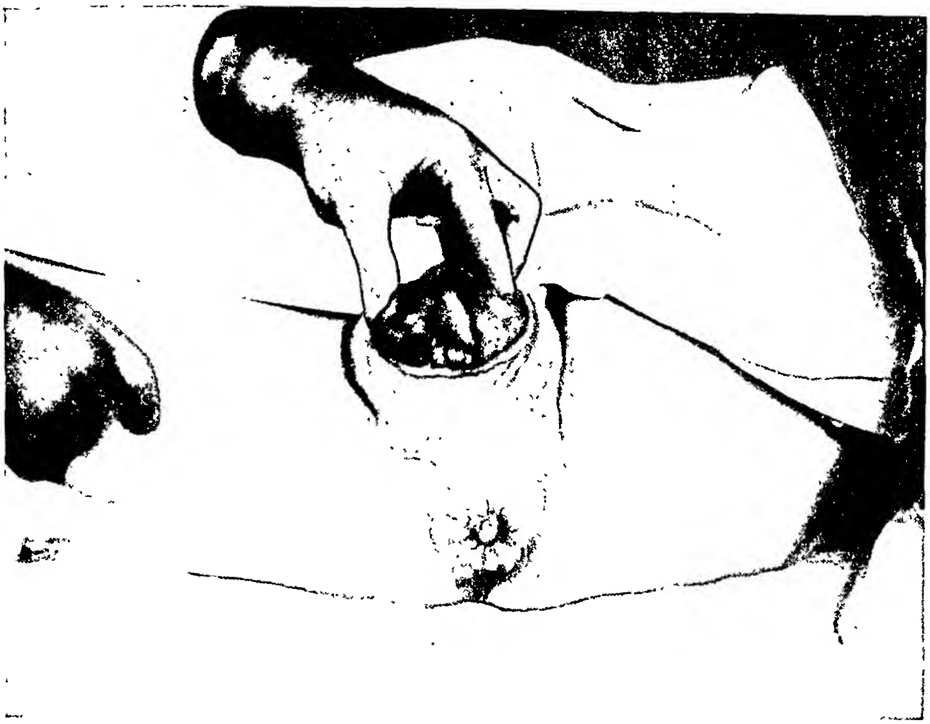

Fig. 425.—Delivery in the dorsal posture. Delivery of the occipital protuberance should be facilitated when necessary by a gentle stripping backward of the anterior vulvar commissure.

Fig. 426.—Delivery in the dorsal posture. Extrusion of the fetal head is accomplished between contractions by a widely spaced grip of the perineum at the anal level. Modified Ritgen maneuver.

Fig. 429.—Delivery in the dorsal posture. Delivery of the posterior shoulder may likewise be spontaneous or may require pressure on the fundus uteri, together with gentle anterior traction on the fetal head. Avoid compression of the vessels of the fetal neck.

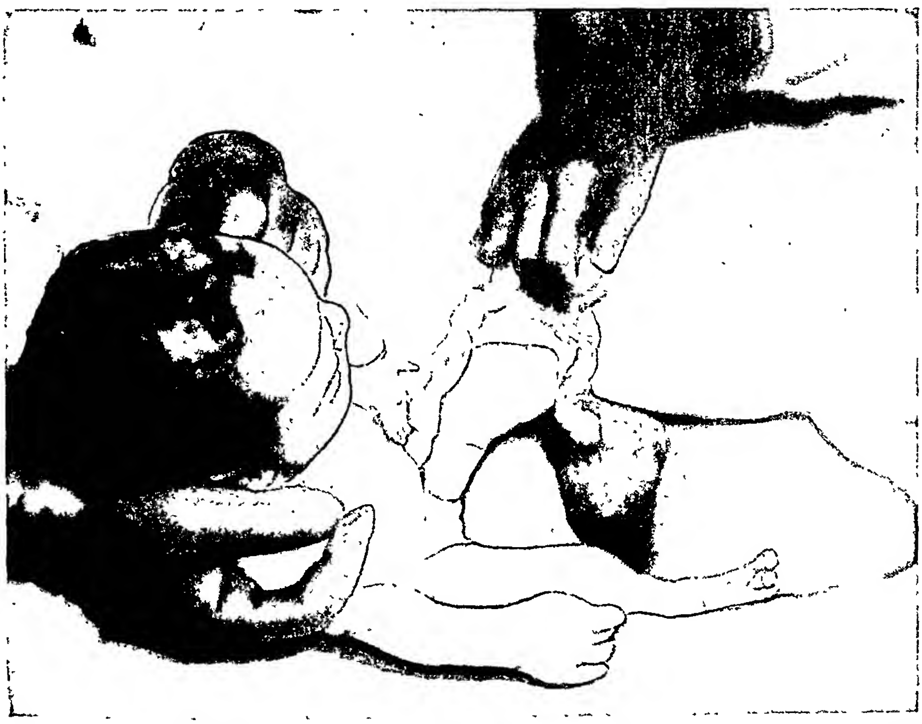

Fig. 430.—Delivery in the dorsal posture. Delivery of the fetal body is accomplished spontaneously or by pressure on the fundus combined with gentle traction in the axillae. The head rests on one or the other hand.

compression effect, simultaneously takes the tension off the perineal body and accomplishes the birth of the head. This final act is best carried out between contractions and meets with no difficulty if not attempted until enough of the fetal head has already come through. If additional expulsive force is needed, pressure on the fundus uteri is permissible.

There is an additional means of preventing the head from being expelled too rapidly in cooperative patients. With each contraction the patient is instructed to breathe rapidly, as if she were panting. This eliminates her voluntary bearing-down efforts for as long a part of the contraction as seems desirable.

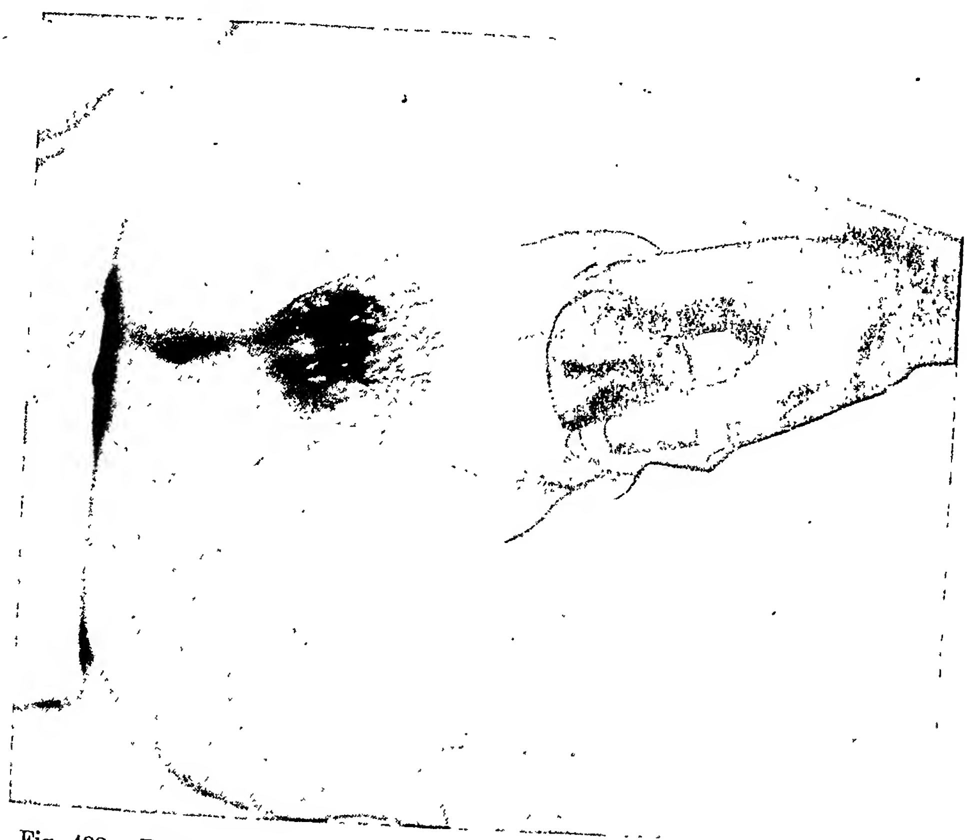

Fig. 433.—Delivery in the lateral posture. The encircling hand is beginning to aid in the stripping back of the anterior commissure. It can still be used to prevent a too rapid advance of the fetal head and to favor increased flexion.

A method of controlled delivery which has not received sufficient recognition is the lateral or side delivery, which is popular in England and continental Europe. If this is to be employed, the patient is turned on her side when the head no longer recedes between pains, if she be a primipara, and when the head is actually visible, if she be a multipara. The accoucheur takes his position on the sacral side of the pelvis facing the lower extremities, and with the arm nearest the patient's head encircles her superior thigh from above downward; her upper foot is rested on her lower knee to keep her thighs widely separated. The encircling hand is used for the retardation of the advancing head, for increasing flexion if desired, and for stripping back the anterior vulvar commissure, as previously described, while the other

of umbilical hernia, the contents of which must be stripped out of the fetal end of the cord, is exceedingly rare but protection against tying the contents of such a hernia is afforded by the same compression which temporarily empties the vein. Ziegler[34] devised an ingenious umbilical clamp, which is apparently proof against subsequent bleeding, can be applied close to the skin, and comes away in from two to four days.

If the infant is crying lustily there is no need for the use of a pharyngeal aspirator. If, however, the efforts at breathing are delayed it is well to aspirate the mucus which may be present in the pharynx. Resuscitation may become the most important part of the entire delivery.

The degree of asphyxia is well indicated by the state of the fetal circulation. The heart beats can be observed or readily palpated under the costal arch. If the rate is normally rapid and the body color is livid, the infant will probably start breathing unaided. It should not be subjected to unnecessary manipulation but merely kept warm. A slowing heart beat and pallid color justify active measures.

In most instances of delayed respiration the difficulty is due to the occlusion of the upper air passages by liquor amnii or mucus which has been aspirated by premature inspiratory efforts while the fetus was still in the birth canal. For this reason the most essential step in resuscitation consists in making sure that the air passages are clear. The first respiratory act of the newly born infant is one of inspiration and if the blocking of the air passages prevents air from getting into the alveoli, then the fetus is unable to cough out such obstructive substances.

Methods of Resuscitation.—The baby should be placed on its back with a rolled towel under the neck. This extends the head and straightens the air passages. Simple external stimuli are sufficient to provoke crying if the air passages are clear. The least injurious of these is the snapping of the soles of the feet with the finger or rubbing the chest and back with a dry towel. These failing, common practice sanctions upending the infant, holding the two ankles with the fingers and thumb of one hand while the buttock is slapped from above downward, not crosswise against the spine. This maneuver serves the double purpose of supplying the external stimulus and possibly of dislodging the mucous plug which may be occluding the larynx. A safer and surer means of establishing respiration lies in the intelligent use of a tracheal catheter. This rather stiff woven rubber catheter, 14 to 15 F., with an opening at the end, can with very slight difficulty be carried over the tongue past the epiglottis and into the larynx under the guidance of the index finger placed in the infant's throat. By this means the contents of the air passages can be removed and the same instruments can be used for artificial respiration. If this should become necessary the body warmth of the infant must be conserved and the head kept well extended; and the physician gently puffs into the lungs an amount of air equivalent to what his mouth will contain with the cheeks slightly distended. If the catheter is in the air passages the chest will be observed to expand and the air will be expired by the natural collapse of the chest without any direct compression effort. These puffs of air should be maintained at the rate of about thirty per minute. Resuscitation has followed this method of artificial respiration even as long as an hour after delivery. So long as the fetal heart continues to beat, however slowly, the procedure should be continued. The

In the system employed at the Michael Reese Hospital a sterilized manila envelope which contains a pair of small aluminum tags stamped with duplicate numbers and sewed on pieces of tape, three pasteboard cards stamped with the same number which likewise appears on the face of the envelope, is opened on the birth bed after delivery. This identification set-up has been sterilized with the contents of the cord box. One of the three pasteboard cards is initialed by the nurse who certifies to the completeness of the contents of the box. The nurse checks all the duplicate numbers and then ties one aluminum tag on the baby's right wrist. This is sewed onto the wrist as soon as the baby reaches the nursery and is not removed until the infant leaves the hospital. The envelope and remaining contents are given to the nurse who receives the infant from the nurse who has wrapped the baby on the birth bed. Each nurse announces aloud the number on the two aluminum tags. The second tag is tied onto the mother's right wrist. The two remaining

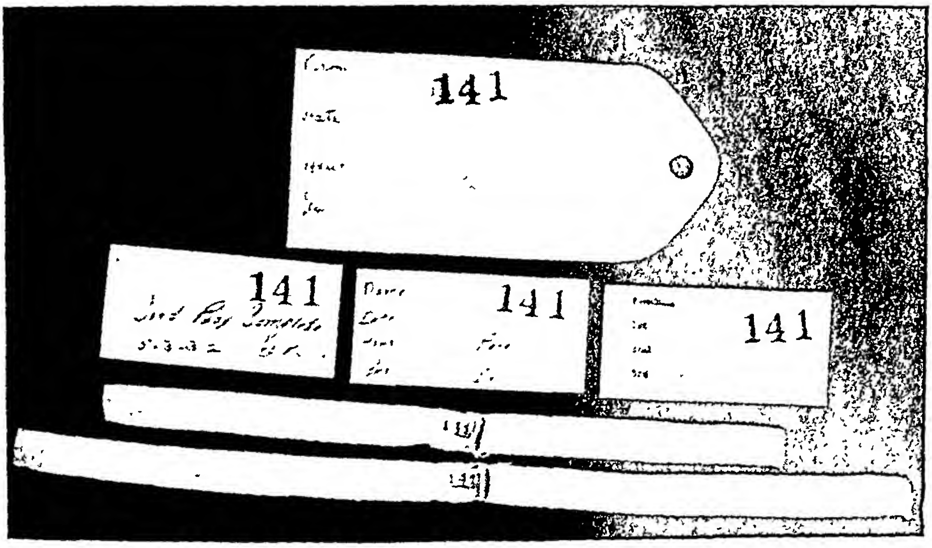

Fig. 440.—Contents of the sterilized identification set up. Envelope, cards, and aluminum tags all carry the same number. Envelope and cards are filled in immediately. Aluminum tags are secured to the right wrist of mother and infant.

cards and face of the envelope are filled in with the name, sex, and minute of birth. One card is placed in a slot on the crib assigned to the baby, the second card is placed in a similar slot at the head of the stall reserved for that crib, while the envelope record is transcribed into a book register kept in the nursery and the envelope itself is preserved by the supervisor.

The most important procedures described above can be carried out within a space of a very few minutes. Thereafter the baby should be enveloped in a sterile blanket and removed from the birth bed. Emphasis should be laid on the importance of conserving the body warmth of the newly born infant. This is especially important for undersized or premature infants.

Ergot and Pituitary Extract.—The use of ergot and pituitrin, which play an important rôle in the treatment of postpartum hemorrhage, has gone through an interesting cycle in the conduct of normal labor. At one time ergot was given promiscuously to hasten the delivery of both the baby and the placenta. Gradually the dangers due to irregular tetanic contractions

such a height that the level of fluid in the bowel and in the reservoir is the same; free to-and-fro motion between them is possible. This avoids discomfort to the patient, and allows expulsion of gas at the same time, keeping a constant amount of fluid in the colon. Some physicians prefer giving fluids by means of repeated, small retention enemas of 200 to 300 cc., repeated as often as necessary.

Certain essentials should be observed in giving fluids by colon, regardless of the method employed. A thorough cleansing enema should be given first. If the colon and rectum contain fecal matter, the fluid is often poorly tolerated or expelled. Absorption from a clean colon is more certain, and the rate probably more rapid than if the fluid is diluted by the fecal content. After the cleansing enema is given it is preferable to wait thirty minutes to one hour before starting proctoclysis. If patients are very nervous and restless, some sedative should precede insertion of the colonic tube. A rectal suppository, containing 1 grain (0.065 Gm.) of opium and $\frac{1}{4}$ grain (0.016 Gm.) of belladonna or a sufficient amount of paregoric may be used. A sufficiently long tube should be employed to insure reaching the colon. This is best inserted under guidance of a finger in the rectum, to be sure that there is no coiling in the rectum. Should this occur, the rectum fills and the patient has difficulty in retaining the solution. In addition, absorption from the rectum is not nearly as efficient as it is from the colon.

The solution for administration by proctoclysis should afford an optimal amount of glucose with sufficient sedative in a medium that will cause the minimal amount of irritation. We have found that a solution of dextrose, 5 or 10 per cent, in physiologic solution of sodium chloride answers very well, or commercial corn syrup can be used in proper solution. At the beginning of treatment, between 90 and 120 grains (6 to 8 Gm.) of sodium bromide is dissolved in each 1000 cc. of the mixture. For the first forty-eight hours as much solution is administered as the patient will tolerate, and the proportion of bromide is maintained. Thus, the three essentials of treatment are fulfilled: Dextrose is given to supply nourishment and to combat the deficiency in glycogen; fluids are administered to replace those lost by the previous dehydration, and sedatives are employed to relieve the nervous irritability, together with chlorides to replace those lost by excessive vomiting. Even if this treatment was kept up for several days, we have never seen a bromide rash in the patients. The exact method of performing proctoclysis will vary with the individual patient. If the enema is well tolerated during the day, and sufficient fluid is taken, it is often well to discontinue the administration at night. This removes a source of disturbance to the patient, and also reduces the likelihood of the colon becoming irritable. If toleration is poor during the day, administration may be kept up for two hours, discontinued for one hour, and so on.

The posture of the patient is important, although in our opinion proper preparation of the colon is more so. If the colon has been well prepared, patients often can lie on the back with good results. In other cases, a pillow may be placed under the hips to elevate slightly the lower part of the bowel; this prevents the solution from returning into the rectum to be expelled. The Sims position with the patient lying on the left side is of advantage because of the anatomical position of the sigmoid and descending colon.

may have become contaminated and so carry infection into the birth canal. If all these clinical evidences are present, it may be properly assumed that the placenta has completely separated.

Extrusion of the placenta, which in the primitive type of woman usually follows immediately after separation, is accomplished by the identical kind

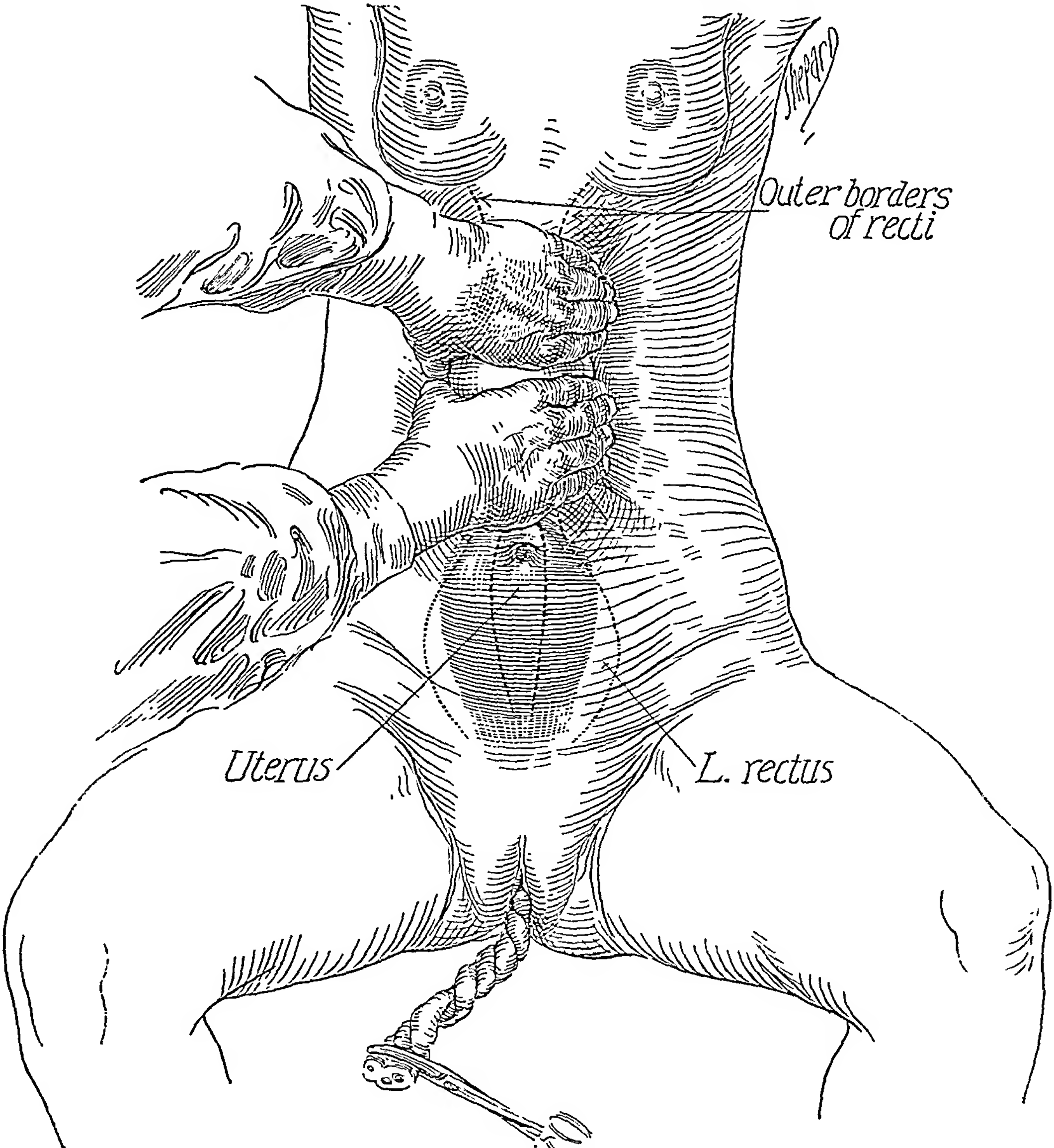

Fig. 443.—Indirect expulsion of the separated placenta. The abdominal recti are grasped at the outer margins in the upper abdomen when the uterus is in firm contraction. They are pulled together toward the midline and held while the patient makes a single vigorous bearing-down effort.

of bearing-down or expulsive effort as was applied toward the expulsion of the fetus. In modern obstetrical practice little has occurred which should interfere with the normal spontaneous act of separation, but much has occurred which prevents spontaneous extrusion of the placenta. The patient is in bed instead of squatting; she is frequently not of the hardy physical

If this does not occur, the author's method of "indirect expulsion" should be attempted.[4, 5] For each of the various methods to be described the bladder should be empty or catheterized, the uterus must be in firm contraction and must be in the midline over the inlet. If the evidences of complete separation are positive and the patient is alert and cooperative, "indirect expulsion" (Baer) may be achieved by a temporary reconstruction of the tone of the abdominal wall. The abdominal recti are grasped at their outer margins in the upper abdomen at a moment when the uterus is in firm contraction. They are pulled together toward the midline and held while the patient makes a single vigorous bearing-down effort. This reinforcement of the abdominal wall enables her in 90 per cent of the instances to achieve a so-called "indirect expulsion of the placenta." This obviates grasping and perhaps unnecessarily mauling the uterus.

If the patient's cooperation cannot be had and separation has occurred, the firmly contracted uterus may be used as a plunger to drive the placenta out of the birth canal (simple expression). This is done by placing four fingers of one or both hands behind the uterus through the indented abdominal wall, the thumbs resting on the anterior surface. At the height of a strong contraction the uterus is pushed (not squeezed) downward in the axis of the inlet and the placenta is expelled. Failure usually means that separation was wrongly diagnosed.

If, after half an hour of waiting, which is entirely permissible provided there has been neither excessive hemorrhage nor shock, it is found that the placenta is not yet separated, then and only then should the "Credé method" of expression of the placenta be employed. This requires that the grasp just described for simple expression of the separated placenta may be employed on the *firmly contracted* uterus, not in a downward propulsion, but in a compression of the corpus especially at its highest point in the abdomen in order to squeeze the retained placenta out of the corpus cavity. When this is accomplished, the placenta is then delivered by a downward push as described for simple expression.

Massage of the uterus has no place in the normal third stage of labor. If separation of the placenta is long delayed, gentle friction of the back wall of the uterus is legitimate to bring on the firm contraction which is necessary before the Credé method can be attempted. Massage may be valuable in the presence of postpartum hemorrhage if it becomes necessary to empty the uterus rapidly (see Postpartum Hemorrhage).

The normal duration of the third stage may be from a few minutes to as many hours as are necessary finally to accomplish the delivery of the placenta by any of these methods. It has been found safe[15, 16] to amputate the cord flush with the cervix and allow the uterine contents to remain undisturbed for as long as twenty-four hours. Common practice, however, justifies termination of the third stage by a manual removal of the placenta after two hours. During this period of waiting, the assumption being that the placenta has not yet separated, the Credé method may be used not oftener than once every fifteen minutes and only at a time of firm contraction.

Waiting is infinitely preferable to and safer than too frequent or too violent attempts at Credé expression or manual removal. While waiting, however, the condition of the patient must be closely observed for evidences of hemorrhage or shock. The former may be external and obvious or concealed

eclamptic toxemia." Commonly, the term, "preeclampsia" is used to indicate the condition which we are calling "severe preeclamptic toxemia."

Chronic nephritis complicating pregnancy has so many symptoms similar to those of the acute toxemias that it seems proper to consider it in a discussion of these conditions. Chronic nephritis is not a toxemia peculiar to the later months of pregnancy and use of the term "chronic nephritis" indicates that the lesion has existed prior to the pregnancy it complicates. However, the behavior of the kidneys with chronic nephritis is affected by pregnancy in a distinctive manner and the resulting symptoms, especially in the milder forms, frequently are not capable of differentiation from the true toxemias. In fact, in many instances a "quiescent" or "occult" chronic nephritis undetected by any clinical or laboratory tests known at present may be revealed only by the "test of pregnancy." An additional reason for including chronic nephritis in a consideration of the toxemias of pregnancy rests on the production of symptoms of nephritis which may later become chronic during the course of many "true" toxemias.

CHRONIC NEPHRITIS

Chronic nephritis is a relatively frequent complication of pregnancy. It is not truly a toxemia of pregnancy, for the renal injury antedates the pregnancy. There is a marked tendency for chronic nephritis to be aggravated during pregnancy, however, and increase in severity may be produced by the same toxic agent that causes the acute toxemia. Usually, symptoms of the exacerbation of chronic nephritis become evident before the third trimester of pregnancy but when the nephritis is more advanced these symptoms may appear early. More rarely, chronic nephritis, previously undiagnosed by clinical or laboratory tests, may be revealed only by symptoms appearing in the course of pregnancy. Chronic nephritis comprises 26.7 per cent of the cases classified at Johns Hopkins Hospital by Stander as cases of toxemia of pregnancy. Gibberd reported 51 cases in which the patients were observed through at least two pregnancies at Guy's Hospital; the first pregnancy was associated with "albuminuria." Four of the patients had chronic nephritis prior to the first pregnancy. Among 97 patients with toxemia delivered by us at St. Mary's Hospital, only 7 per cent had chronic nephritis prior to pregnancy.

Etiology.—Chronic nephritis which exists prior to any given pregnancy may follow a contagious disease of childhood, such as scarlet fever, or may be the result of some infectious focus such as may be present in the tonsils or teeth; or the renal injury may have been caused by previous toxemia of pregnancy. In fact, experience has shown that preeclamptic toxemia is by no means a small factor in production of chronic nephritis, and that frequently the injury to the kidney is increased by each subsequent pregnancy. In six of Gibberd's cases in which albuminuria was noted an average of nine weeks prior to termination of pregnancy, chronic nephritis developed. Thirty-three of our toxemic patients, none of whom had preexisting nephritis, were observed through one or more subsequent pregnancies. Eight patients gave definite evidence of a more or less severe grade of chronic nephritis, and seven manifested suggestive but not conclusive evidence of chronic nephritis. Caldwell and Lyle reported an incidence of chronic nephritis of 8 per cent after eclampsia. Gibson found that in 5 of 14 cases of eclampsia

Repair of Birth Injuries.—Injuries to the birth canal in an otherwise normal labor occur most commonly at the cervix and at the introitus. In the course of a normal labor the cervix is usually effaced and dilated by the hydrostatic effect of the contents of the intact membranes which distribute the contractile action of the uterus evenly against the internal os and finally against the external os, together with the upward pull of the uterine wall. At the completion of the first stage of labor the cervix has been merged into the lower uterine segment and the external os has been so completely dilated that it is essentially flush with the vaginal walls.

In the vast majority of instances inspection of the reformed cervix six weeks after delivery reveals a transformation of the original circular orifice of the external os of the nullipara into a transverse oval aperture of an average diameter of 1 cm. The cervix itself differs from the nulliparous cervix in that it is more nearly cylindrical than tapering and there may now be recognizable a division into the so-called "anterior and posterior lips of the cervix." Inspection and palpation of this same cervix immediately after delivery frequently reveals a more striking division into more or less edematous anterior and posterior lips with a very thin lateral structure. The margins representing the original external os may be entirely intact or there may be on one or the other side a tear in the thinner connecting structure varying in depth from a shallow nick to a tear extending to or into the vaginal fornix.

Routine inspection following all deliveries has been urged with the thought that tears when found should be repaired while fresh to avoid the formation of scar tissue, eversion of either or both lips of the cervix and the possibility of the development of carcinoma in such tissue.

In the evaluation of this well-intentioned advice it must be remembered that the cervix as seen immediately after delivery is in its maximum degree of dilatation and traumatic edema and that the edges recommended for immediate repair by suture are usually of paper-like thinness. A lateral tear 2 cm. long at delivery is not more than one fifth of the distance to the top of the lateral vaginal fornix so that when involution has been completed this tear will be scarcely more than a nick in the oval aperture of the reformed cervix. Furthermore, it is entirely conceivable that the asepsis which is now beginning to be practiced in deliveries generally in the home as well as in institutions is quite likely to be less efficient when applied to the routine exposure and manipulation of the cervix after delivery. It would seem, therefore, that such inspection and immediate surgical repair of the cervix could very properly be limited to those instances in which the cervix may have been subjected to expulsive efforts before complete dilatation has occurred, to that group of patients in whom major operative procedures had been carried out, to instances of tumultuous and rapid labor, and lastly in the presence of hemorrhage. In the remainder if final inspection after involution is completed reveals eversion and beginning ectropion, the electrocautery[14] furnishes a simple and efficient correction of the beginning pathology.

If appreciable tears of the cervix are found the repair should consist of a series of interrupted through-and-through catgut stitches, preferably No. 2 twenty-day chromic. The first stitch should be placed just above the uppermost angle of the tear and succeeding ones should be spaced not closer than 1 cm. apart to avoid strangulation of the tissue. They should be tied for

lymph supply, bacterial invasion may thrive on an overabundance of buried catgut, resulting in infection and nonunion of the perineal body. For this reason it would seem safer wherever the depth of the injury is not too great to resort to the interlocking continuous suture pulled together for approximation only and in two or three sections if need be.

Precise anatomical reconstruction is, of course, highly desirable but requires the use of considerable catgut even though this be in the form of a long continuous suture which is reversed in direction in the different planes. The functional end-result should be gauged by the thickness of the perineal wedge and the reestablishment of levator continuity in those instances in which the levator has been involved, rather than by the cosmetic result obtained. Since this end-result can be obtained by the above-described methods of repair, burying of a large amount of catgut seems unnecessary.

Third-degree tears, if properly united under strict aseptic precautions immediately after they occur, heal almost invariably. The obstetrician, however, must know how to carry out this type of repair. The first step consists in the reconstruction of the anterior rectal wall, if this has been torn, by fine interrupted submucous chromic catgut sutures, the knot being placed on the vaginal side of the wall. The sphincter ends are then united above the reconstructed anterior rectal wall by two separate mattress sutures of No. 2 catgut and reinforced by a through-and-through suture of silkworm gut. The remainder of the repair is then identical with the repair of any second-degree tear.

Final Considerations.—A sound approach to the consideration of the conduct of labor requires the acceptance of two statements of fact, namely: *labor is the high point in a series of physiologic processes, and every woman in labor is a potential emergency major surgical risk.*

The drive to elevate obstetrics to its proper plane will have attained one of its objectives when these two postulates are recognized and sound judgment is coupled with full preparedness in the care of every woman in labor.

It is obvious that women through the ages have given birth without skilled assistance and have recovered in the vast majority of instances with little or no serious handicap resulting. Nevertheless it is the aim of modern obstetrical practice to so conduct deliveries that women shall be spared injuries and infection even to the point of invalidism or death, and to so guard and protect the larger group of comparatively normal types that they shall be restored in structure and function.

Obstetrics today is slowly but steadily being transferred from the home to institutions more or less well adapted for the conduct of every type of delivery. There can be no doubt that the woman in labor is infinitely better safeguarded in a well-conducted and suitably manned hospital than in a private home, no matter how much pain has been taken to convert the home temporarily into a hospital. It therefore behooves the obstetrical profession to press for improvement in several directions. Maternity institutions must be provided in ever-increasing numbers, their capacity enlarged, and the personnel, both doctors and nurses, must be increased and must maintain a standard of excellence which will justify the trend from the home to the hospital.

This problem involves the teaching of obstetrics, which in past decades

CHAPTER XXV

THE PUERPERIUM

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The word puerperium is derived from the latin *puer*, a child, and *parere*, to bring forth. By it we designate that period of time between the delivery of the child and the return, not only of the reproductive organs, but of the entire organism of the woman to the condition in which they were prior to the beginning of pregnancy.

This definition must be taken with a certain degree of reserve, as, especially after a first pregnancy and labor, certain evidences remain which indicate clearly that pregnancy and labor have occurred. The striae gravidarum, the alteration in the configuration of the os externum cervicis and possibly the presence of cervical injury, perineal injury, relaxation of the anterior vaginal wall and changes in the breasts may be mentioned as examples.

The length of time which is required for the return to the normal nonpregnant state varies somewhat but in general about eight weeks are needed for the process of involution to be completed. The rate at which the involutionary changes proceed is most rapid during the first few days, goes on more slowly thereafter, and the final attainment of the normal nonpregnant condition is quite gradual.

The progress of the puerperium must be influenced materially by the character of the labor which preceded it. A normal pregnancy and a normal labor will in all probability be followed by a normal puerperium. A lack of the asepsis so essential to the proper conduct of labor may seriously change the character of the puerperium. The recovery from a serious operative delivery, especially if extensive birth injuries have occurred, is likely to be more troublesome than convalescence after a normal birth. Judgment in the selection of operative procedures, or better, in refraining from those which may not be needed, and skill in the performance of those which are essential, improves the outlook of the parturient woman in the puerperium no less than during labor.

Changes in Apparent Size of the Uterus.—Immediately after the birth of the child, if the bladder is empty, the upper limit of the uterus will be found about two fingerbreadths under the umbilicus, or 12 cm. over the symphysis. These limits are not invariably exactly as stated, for the location of the umbilicus may vary somewhat in different individuals and the size of the uterus may also not be the same in all women. The uterus of a multipara is, as a rule, a little larger than that of a primipara. The width of the uterus at this time, at the level of the insertion of the tubes, is 11 to 12 cm.

The shape of the uterus is characteristic. If its cavity is normally empty, so that the anterior and posterior walls lie in contact with each other, its anteroposterior diameter is less than the lateral one. A rounded, ball-like

normally rises a little above the symphysis. From a practical point of view the statement may be allowed to stand, as the uterus is no longer to be felt.

Anatomical Changes in the Uterus.—The empty uterus as noted at cesarean section shows a grayish tint which is quite different from the bluish hue of pregnancy. Its surface is somewhat wrinkled, due to the fact that the peritoneal covering of the corpus and fundus is attached firmly to the organ and does not move as does the peritoneum of the plica uterovesicalis. This causes the serosa to follow the irregularities of the contracting muscular wall, thus producing an uneven surface.

The change in weight of the uterus during the puerperal period is considerable. Immediately after expulsion of its contents it weighs about

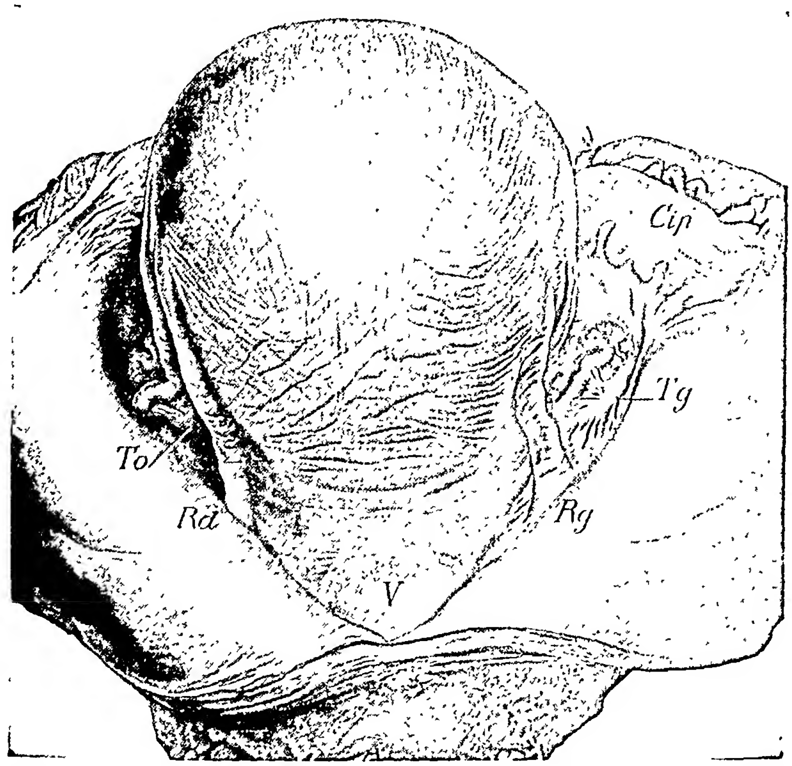


Fig. 448.—Couvelaire. Uterus postpartum. Para IV, dead one hour after delivery. Clinique Baudelocque, Prof. Pinard. The surface of the uterus is wrinkled by transverse furrows. *AP*, Pubic arch; *V*, bladder; *Rd*, right round ligament; *Rg*, left round ligament; *To*, tubo-ovarian vessels under the right mesosalpinx; *Tg*, left tube; *Cip*, ileopelvic colon.

1000 Gm. The weight varies considerably in different women and is influenced by the size of the uterine contents. According to Couvelaire[6] it may reach 1500 Gm. At the end of the first week the weight has been reduced about one half, at the end of two weeks it is about one third as much as immediately after delivery, and, at the end of the puerperium, that is, in eight weeks, it has been reduced to 40 to 60 Gm.

It was formerly believed that this enormous reduction in weight and bulk was accomplished by the actual destruction of muscle cells. Kölliker[22] believed that a portion of the muscularis disappeared. The work of Sänger[32] showed that the number of muscle cells was not reduced but that the decrease in size of the uterus was brought about by the disappearance of a portion of

The degenerative process here is greater and takes a little more time; a greater amount of epithelium must be formed, owing to the larger area of the denuded spaces, and healing is therefore slower.

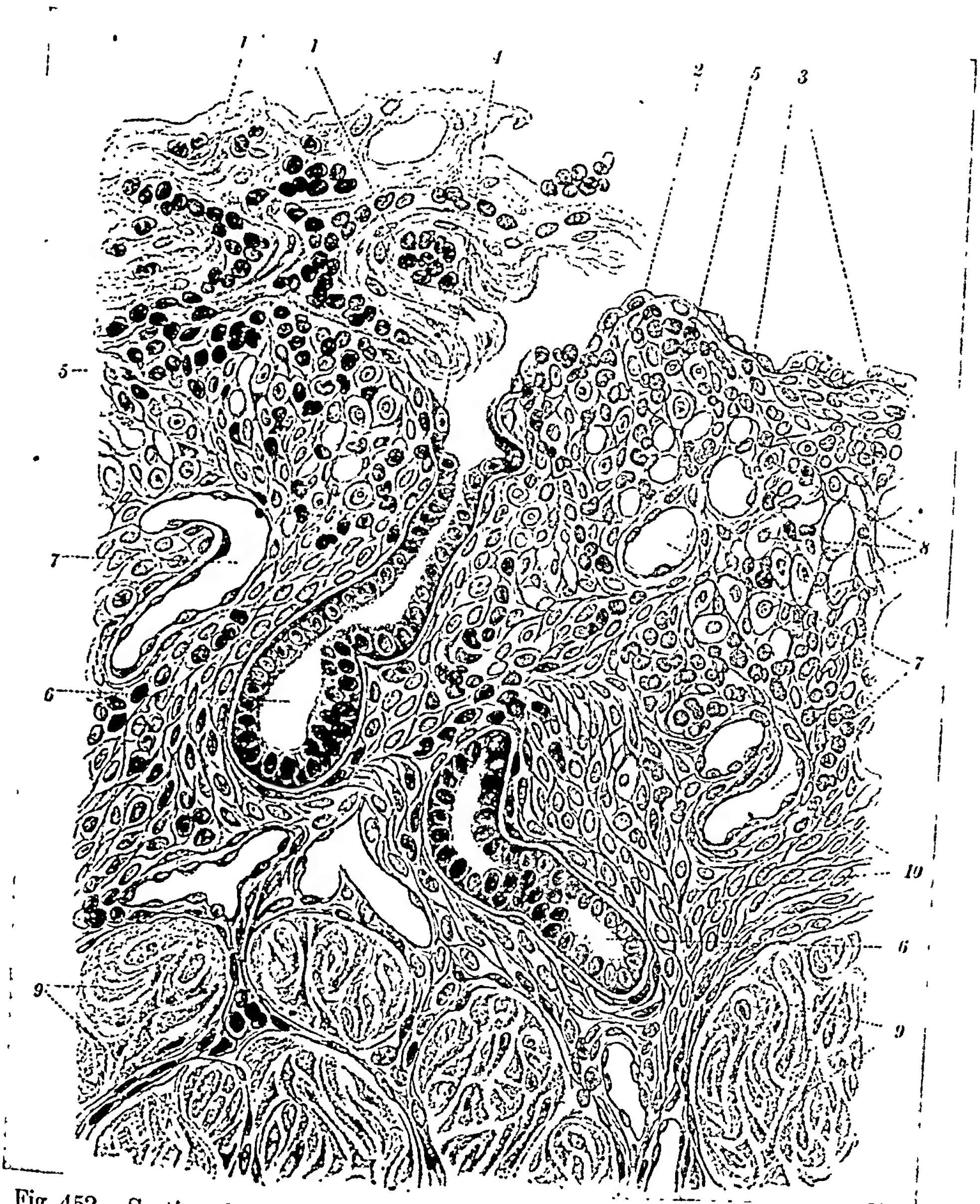


Fig. 452.—Section through the regenerating mucosa uteri on the sixth day of the puerperium. (Bumm.) *1*, Superficial necrotic layer of decidua, filled with leukocytes and in process of being cast off; *2*, exposed surface of decidua; *3*, layer of epithelium regenerating; *4*, epithelium growing upward from the lumen of a gland; *5*, granulation layer. Line of demarcation from the necrotic surface layer; *6*, remaining portion of the glands in the decidua; *7*, capillary vessels; *8*, decidua cells which are breaking down in a network of connective tissue fibers; *9*, muscularis; *10*, deepest layer of decidua with spindle cells.

Changes in the Vessels of the Uterus.—The changes in the structure of the puerperal uterus were studied by Goodall[14] who concluded that after each pregnancy the uterus reconstructed all its vessels. It is his view that at the placental site new arteries are developed within the old ones, all three

Changes in the Vagina.—The vagina has undergone great distention, and, particularly in primiparae, there is often considerable injury. The lesions may vary from tiny first degree injuries to extensive lacerations extending into the rectum. Tears of the upper vaginal wall may also occur. Submucous laceration or solution of continuity of the muscular and fascial structures of the pelvic floor may be present, resulting in the later appearance of a rectocele, although visible injury may not have appeared on the surface. Fortunately, vaginal wounds heal rapidly and satisfactorily during the puerperium if uninfected and if reasonably skilful repair has been done.

Immediately after labor, because of the great distention, and also as a result of the marked succulence and turgescence of the vaginal walls, the vagina is a relaxed and capacious tube. The stretched structures begin in a few days to recover their normal tonus and the marked hyperemia of the vaginal wall lessens, but it requires a considerable period, from six to eight weeks, for the walls to recover their elasticity completely and for the mucosa to reassume its normal color. After a first labor a complete return to the status quo ante partum is almost never attained. Relaxation to a greater or less degree of the anterior wall and pelvic floor is almost without exception observed. Small tags of mucosa about the introitus, the *carunculae myrtiformes*, remain as the remnants of the hymen. The labia minora and majora are looser and flabbier and the introitus tends to gape more or less. The appearance of the vulva and introitus vary within wide limits according to the amount of injury and the character of healing.

Immediately after delivery a marked relaxation of the abdominal wall is present. Especially in thin women is this observed. The skin surface may be wrinkled, lying in some cases almost in folds. A diastasis of the recti muscles is as a rule present, and in the efforts of vomiting the skin and peritoneum, with the thinly stretched fascial structures between them, may be observed to push out between the edges of the separated recti. A hand placed in the median line will easily distinguish the edges of the muscles. The elasticity of the abdominal wall is regained during the puerperal period but rarely does the abdominal wall resume completely its pregestational state. The circumference of the body about the abdomen is 2 to 3 inches greater than before and, in some cases, more or less diastasis of the recti muscles remains.

The Lochia.—Immediately after labor, and for the first few days of the puerperium, a bloody discharge occurs. The character of the lochia changes as the process of healing in the uterus progresses, the rate of alteration in appearance varying somewhat in different women. The average cycle is approximately as follows: The first two to four days the lochia is bloody, at first composed of blood only, possibly containing small clots. This stage of the lochial flow is termed *lochia rubra* or *lochia cruenta.* If the clots are other than quite small or if the amount of blood lost is too great the bleeding may be regarded as abnormal.

After the first three or four days the color changes, becoming paler with a tinge of brown. This is due to a lesser amount of blood and to the presence of a larger proportion of serous discharge. The brownish tint is caused by chemical alteration of the lessened quantity of blood as it comes in contact with the vaginal secretion. This stage is known as *lochia serosa* or *lochia sanguinolenta.*

of the vaginal secretion, the coccal forms predominating during the puerperium instead of the bacilli which are more numerous prior to parturition.

The disappearance of bacteria from the uterus begins within two or three weeks after delivery. The normal sterility of the uterine cavity is then gradually reestablished. The return of the vaginal bacterial flora to normal requires a longer time.

MANAGEMENT OF THE PUERPERIUM

Immediately after completion of delivery, and after any necessary reparative procedure has been finished, the patient is prepared for bed. The vulva and surrounding area are cleansed. A sterile vulvar pad is placed over the introitus and kept in place by a T binder. The patient should be transported to her bed as soon as it is evident that danger of blood loss or other obstetrical complication does not require a longer stay in the delivery room. A blanket-warmer is a desirable part of the equipment of a delivery floor in order that recently delivered women may be covered with warm blankets during the journey through hospital corridors, thus minimizing the loss of body heat.

About one third of parturient women, soon after the completion of the third stage, experience a chill which may be more or less severe. It has no serious significance and disappears in a few minutes, usually five to ten. Many explanations have been offered as its cause. Bumm[4] inclines to the belief that it is due to the presence of substances in the blood stream resulting from a regressive metabolism caused by the great muscular activity of labor.

After the patient has been put to bed the uterus should be observed for possible relaxation and bleeding. A hand placed upon it will determine whether it is firmly contracted or in a soft and relaxed state. If a tendency to softening is noted the uterus may be stimulated to contract by massage. If the uterus is well contracted no forceful manipulations should be carried out as massage of the uterus causes discomfort or even pain and the chief need of the puerpera at this time is rest. The patient should be left in quiet and allowed to sleep if possible. Many women will be able to sleep at once but others, owing to exhaustion, discomfort or excitement, will find difficulty in doing so. Some simple sedative, as sodium amytal, 0.18 to 0.36 Gm. (3–6 grains), may help, and, if necessary, morphine sulphate, 0.01 Gm. ($\frac{1}{6}$ grain), may be given hypodermically. Particularly after a trying labor rest is essential. To this end much visiting should be discouraged. A good practical rule is to limit visitors for the first week to the immediate family circle. The fatigue which the puerpera may experience from many visitors is not appreciated by friends and relatives and, apparently, by some physicians.

The patient may be permitted to lie upon her back or upon either side as she may desire. It is not necessary that movement in bed should be restricted.

The vulvar pad should be changed whenever it becomes filled with blood. The number of pads may serve as a rough index of the amount of lochial flow. The pad serves to absorb the flow and to limit contamination from without. Every four hours, and after evacuation of the bowels and urination, a low pressure external irrigation or "pitcher douche" is given. The patient is placed upon a bed pan and a solution of weak antiseptic is permitted to flow over the vulva. A weak cresol or bichloride of mercury solu-

factorily explained before any hypothesis becomes acceptable. Why does this disease occur in the later months of pregnancy in the human race only? Why do two thirds of the cases occur in primiparas, and why may it occur in cases of hydatidiform mole without the presence of a fetus? Why should it occur more frequently when the uterus is overdistended by hydramnios or multiple pregnancy? Why does it occur more rarely in the tropics than in more temperate climates? Why does adequate prenatal care so markedly reduce the incidence of eclampsia? What is the toxic substance which causes one pregnant woman to have eclampsia, but not another woman under the same external conditions; what is the toxic substance which causes the same woman to have eclampsia in one pregnancy and not in a subsequent pregnancy? Added proof would be obtained if a toxic substance should be discovered, which could produce generalized systemic arteriolar injury, including typical hepatic and renal lesions in a majority of cases. Some of the hypotheses of etiology which will now be considered are listed under the following headings:

- Bacterial causes.
- Maternal causes:
  - Dietary.
  - Intestinal.
  - Mammary.
  - Metabolic changes.
  - Endocrine disturbances.
- Fetal causes:
  - Biologic reactions.
  - Entrance of fetal elements or fetal metabolic products into maternal circulation.
- Placental causes.
- Physiologic-chemical causes.

In 1843, Lever expressed his thought that eclampsia is due to uremia. This idea was accepted for many years but has few advocates at the present time. Stander[121] summarized the opinions of Volhard, Paramore, and others on the renal origin of eclampsia. Volhard regarded eclampsia as a form of acute uremia. Paramore held that the convulsions are preceded by renal dysfunction and that diminished output of urine is a constant finding in the preeclamptic state; however, he felt that eclampsia must depend on some other factor than inefficient kidneys. FitzGibbon expressed the belief that the cause of preeclamptic toxemia or eclampsia is failure of the organs of elimination to take care of the extra demands incident to pregnancy; Casamanda, however, found no association between eclampsia and kidney toxemias.

Talbot, Lavake, and others have restated the hypothesis that these forms of toxemia are of infectious origin. Browne suggested that preeclamptic toxemia is due to absorption of infected placental infarcts. DeLee called attention to the frequent association of infections of the urinary tract and late toxemias of pregnancy. Bugbee gave us his feeling that the evidence that urinary infection causes eclampsia has no clear proof, and Theobald observed the almost complete absence of toxemia of pregnancy in Siam, where dental and urinary infections are prevalent.

The theory that dietary disturbances play a large part in the production of preeclamptic toxemia received added support with the reduction of the

in these women appear to be largely composed of fat with a relatively small amount of glandular tissue. In general, women with well-developed firm breasts of moderate size, in which the glandular structure is palpable, are prone to nurse well. Small, slender women generally nurse better than obese women. The amount of milk may be said to average from 600 to 800 cc. per day from a woman of normal milk-producing ability with an actively nursing infant. The amount varies with the requirements of the infant. An actively nursing babe is the best stimulant for milk production. Women who serve as wet nurses in institutions sometimes produce great quantities of milk, as much as 2500 to 2800 cc. per day being recorded (Budin[3]).

Various drugs and proprietary liquids have been recommended or advertised as "galactogogues" or stimulants to milk production. They are of no value. The mother's digestive processes should be allowed to devote themselves wholly to the assimilation of necessary food and water and should not be disturbed by futile medication.

For a complete consideration of the details of breast feeding and of the chemistry of the milk and colostrum the reader is referred to Pfaundler.[30]

The puerpera should be briefly instructed in simple language as to the physiology of lactation and warned against the silly advice which she is certain to receive from older women. She will be told that she must eat large amounts and that she must take milk and gruels freely. These statements are not true. One may with profit consider the course pursued by the successful dairy farmer with his milk-producing cows. Four cardinal points appear. First, the animals are given a plentiful supply of clean water; second, they are allowed to eat of their accustomed articles of food as much as will satisfy their appetites but are not urged to overeat; third, they are not made to work; and fourth, they are not harassed, frightened, or nervously upset. In the best dairy stables attendants are not allowed to abuse the animals physically or verbally as experience shows it affects the milk supply. As the physiologic process of milk production is quite the same in the human female as in the lower animals, it is well to consider the factors which influence milk production in the latter. The nursing mother should have an abundant amount of water, and a varied diet made up of simple wholesome foods, leaving out those articles of diet which are known to disagree. She will nurse more successfully if she is not burdened with physical or mental work. Social activities, club work and the like should be given up or at least greatly curtailed. She should be spared all possible worry and nervous excitement. In short, the nursing mother, to almost the same degree as the pregnant woman, should receive every possible consideration from those who are charged with her happiness. It must not be forgotten, however, that individual variations in the ability to produce milk are observed and some women are far less able to do so than others. The same variation is noted in dairy animals.

The advent of a new pregnancy will alter the milk secretion. The milk becomes poorer in quality and the amount diminishes. Nursing should be stopped. A woman should not be required to nourish a fetus in utero and a child at the breast at the same time.

The quality of the milk may vary widely in the same woman at different times. The milk obtained at the beginning of nursing or expression from a full breast will be found to be different from that obtained at the end, the

uterus is in normal position, whether the perineum has healed well in case any repair has been done, and whether any notable damage to the cervix remains. This should be done with the utmost gentleness in order that the pelvic structures may be disturbed as little as possible. If infection is present examination should be omitted. A simple rectal examination will afford sufficient information except as to the cervix and is preferred by some obstetricians.

If a retrodisplacement is present the young mother should be asked to assume the knee-chest position twice daily for ten minutes each time. It is always well to show her how this is done, or have her instructed by a nurse who knows what the knee-chest posture is. Otherwise she is almost certain to assume a faulty attitude. As an alternative to this, if she cannot take the knee-chest position, the "monkey walk" may be suggested. The woman walks upon her hands and feet, the knees and elbows being held straight. The knee-chest position is of service in the majority of cases and in a fair number of instances suffices alone to cause a uterus which is retrodisplaced

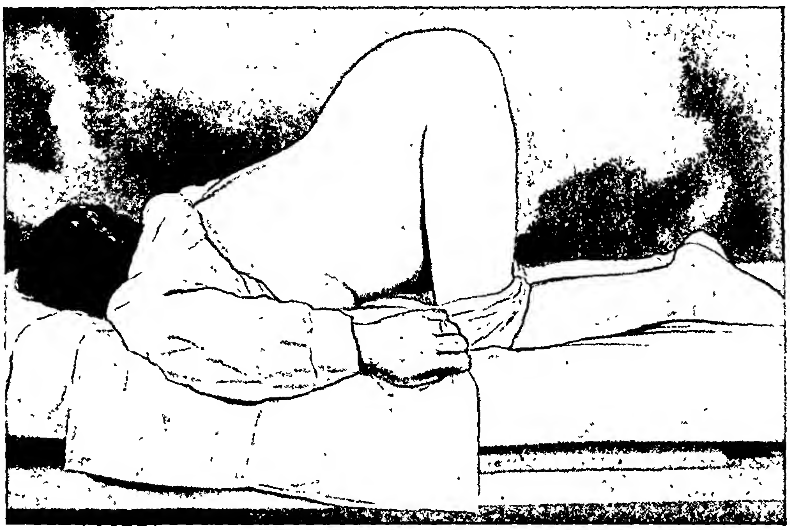


Fig. 455.—Knee-chest position. (DeLee, "Principles of Obstetrics.")

at the time of discharge from the hospital to be found in anteflexion a month later. Should the uterus be found in the backward position at the time of the final examination it should be manually reposited and held in anteposition by a pessary for a period of two months. A week after the pessary is put in it is wise to reexamine to be certain that it is not causing undue pressure anywhere and that it is holding the uterus in proper position. It should be removed at the end of a month for cleansing and to permit inspection of the vaginal mucosa for possible damage from pressure, and then replaced for another month. In a series of 1000 private cases studied by Danforth and Galloway,[9] retrodisplacement was found either during pregnancy or the puerperium in 18 per cent. It is always well to replace a retrodisplaced uterus as the backward position causes a passive hyperemia which hinders the process of involution. Bleeding during the puerperium is occasionally caused by this condition and a reposition of the uterus may, without further treatment, be sufficient to control it.

A very satisfactory plan is to put the child to the breast every four hours, from six in the morning until ten at night. In our own service we have found it entirely possible to omit the feeding at 2 A. M., which ordinarily would form a part of this schedule, when the child weighs 7 pounds or over. This spares the mother the breaking of her rest at that time and allows her to sleep uninterruptedly from ten until six. The length of individual nursings varies widely. Some infants obtain a sufficient amount in five to eight minutes while others must nurse much longer. As a rule nursings may be restricted to twenty minutes. The details of infant feeding belong in the domain of pediatrics and will not be considered here.

Small cracks or fissures may develop upon the nipples and cause the mother considerable discomfort and in some cases much pain in nursing. They are a source of danger as well as they provide an avenue for the entrance of bacteria and thus may be the starting point of infection. The best treatment for such fissures is the application by means of a tightly wound applicator of an antiseptic. This serves merely to kill or to hinder the development of such organisms as may be present in the fissure and so may be looked upon as a preventive rather than as a curative measure. The various pastes and ointments which are recommended for cracked nipples are of little value and are not advocated. The cracks heal in spite of rather than because of them. The fissures will heal rapidly with rest, and could nursing be given up, would soon disappear. In some cases a glass and rubber nipple shield may be used through which the child may nurse. This will serve in only a few cases but where it can be used it is of considerable value. Nursing may be given up for a day or more from the affected breast and the breast emptied by means of one of the power-driven devices such as the electric breast pump of Abt. The milk so obtained may be given to the infant.

Inverted or depressed nipples are difficult to deal with. One may attempt to draw them out during pregnancy but such efforts often meet with no more than a partial success. During the puerperium gentle attempts to draw out the nipple with the fingers may be made, these being too often no more effective than during pregnancy. A vigorously nursing child or the use of the electric breast pump may help, but if improvement does not rapidly follow it is best as a rule to discontinue attempts at nursing and begin artificial feeding.

Some support is often needed and a brassiere of the uplift type may be used. Care should be taken to use no sort of breast support which will cause the functioning breasts to be crowded against the chest wall.

Should it be necessary to cease breast feeding it is quite needless to make use of any of the series of measures which have been employed to stop the flow of milk. Drastic hydragogue cathartics cause the woman needless discomfort and exercise little if any influence upon milk secretion. The application of belladonna ointment or similar applications is of no value. Tightly bandaging the breasts does not hasten the cessation of lactation and very tight bandages are uncomfortable. A support for the heavy engorged breasts may give some comfort. It is best not to pump the breasts at this time as emptying them tends to stimulate further milk production. Only when discomfort is very great may a little relief be given by pumping. It is better that it should not be done at all. Ice-bags may be applied if the discomfort is considerable. Some women prefer heat, and as neither heat nor cold

tion alone will cause fever. The appearance of fever beyond the limits set in the standard given above must be regarded as probably due to infection in the pelvis. If infection in the reproductive tract is excluded the cause must be sought elsewhere. Urinary infection, infection of the breasts, and diseases of the respiratory tract are frequent sources of fever.

The Pulse.—The emptying of the uterus allows the heart to return to its normal location. This causes the area of precordial dulness to become narrower than it was during pregnancy and the apex beat moves somewhat inward and downward. The elimination of the uteroplacental circulation lessens considerably the work of the heart.

Murmurs are not infrequent during the puerperium and the frequency of these and their intensity seems to have a relationship to the amount of blood loss.

It has long been assumed that bradycardia is normal during the puerperium. This idea was suggested by Blot[1] and has been repeated and commented upon in a large number of publications. It is true that in a normal puerpera the pulse is somewhat slower than at other times but a marked degree of bradycardia is not the rule. In a few cases slowing of the pulse to 40 or 50 beats per minute may be noted but a rate of 68 to 80 is more common. Labhardt,[24] in 5000 puerperal women, found a rate of less than 60 in only 2 cases and regards a very slow pulse as a rare exception.

It is probable that rest and the recumbent position of the puerperium, the lessened burden of the heart, the diminished food intake and the quiet of the lying-in chamber cause the slowing of the pulse rate.

The most definite characteristic of the pulse during the puerperium is its lability. The rate in any case varies with the amount of blood loss sustained during labor, being rapid and small if severe bleeding has taken place. If the amount of blood loss is normal, the pulse rate is still easily altered, even the arrival of visitors affecting it in some women. It is as a rule immediately affected by fever and a rising pulse rate warns of the possibility of infection.

The Skin.—During the first day, and to a lesser degree during the early days of the puerperium, profuse sweating may occur, in some cases sufficiently profuse to necessitate a change of linen. In a few cases the profuse perspiration may persist for a longer time, but as a rule it ceases in a few days. The perspiration is favored by the blood loss of the labor with it consequently increased fluid intake and by the warm covering which the puerperal woman as a rule receives. In addition to these factors it has been suggested that certain toxic bodies in the circulation, products of labor and the beginning of involution, play a part in the causation of sweating.

Charles White,[38] in 1773, insisted that the profuse sweating of puerperal women was increased by the custom at that time of covering them heavily with blankets even in mild weather and by the prohibition of ventilation, and maintained that they would be benefited by more air, less covering and a consequent lessening of fluid loss through the skin.

The increased capillary growth on the lower abdomen and over the pubes recedes spontaneously as recovery from pregnancy and labor proceeds. The pigmentation of the skin characteristic of pregnancy also lessens greatly but may not wholly disappear. The linea nigra upon the abdomen becomes much paler or disappears and any pigmentation which may have been present

tive procedure which may have been done, and upon the degree of disproportion. Swelling of the vesical and urethral mucosa may offer mechanical obstruction to the outflow of urine and the loose abdominal wall of the early puerperium renders it more difficult for the patient voluntarily to make expulsive efforts. Some women cannot empty the bladder in the recumbent position at any time.

If the retention is unrecognized and uncared for it is quite possible for the bladder to fill up to its capacity and then to overflow. The woman may void spontaneously and yet the catheter, as occurred in a case seen by the author, may evacuate over a liter of urine.

It is important, during the early days of the puerperium, to avoid overdistention of the bladder. If this is permitted to take place, the musculature of the bladder is stretched and loses for the time being its tonus with a consequent inability to void spontaneously. The bladder must be emptied by catheterization at regular intervals until it regains its normal ability to empty itself.

In many cases the bladder will be partially emptied, a certain amount of residual urine remaining. The presence of residual urine carries with it a risk to the woman as cystitis is far more likely in the presence of residual urine.

A definite course should be followed in order to avoid either overfilling of the bladder or the retention of residual urine. It should be borne in mind that the bladder during the puerperium may be greatly distended without causing pain and the evidence of pain should not be awaited. Inspection and palpation of the lower abdomen will reveal a fluctuant tumor just over the symphysis if the bladder is distended.

The plan which for some years has been successful in the author's hands is as follows:

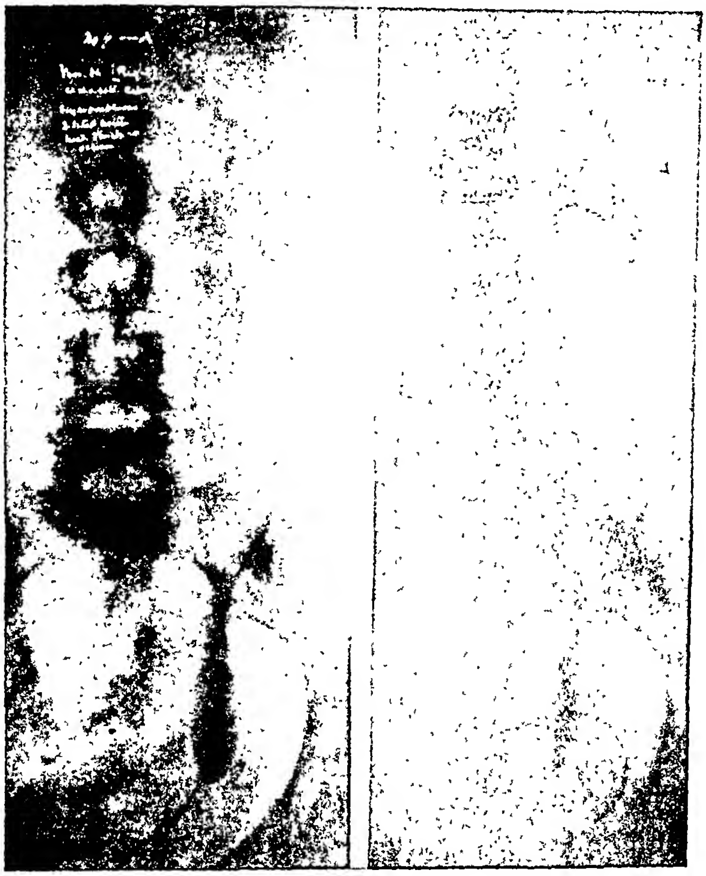
Twelve hours after delivery, if the patient has not voided and if prior to that time the bladder has not distended to a point which can be recognized, the bladder is emptied by catheter. After that time the bladder is evacuated by catheter every eight hours until spontaneous urination begins. When spontaneous urination occurs, a test catheterization is done, that is, immediately after voiding the catheter is passed in order to ascertain whether the bladder has completely emptied itself. If the residual urine obtained by catheterization is less than 30 cc. it is assumed that the bladder function has been restored sufficiently nearly to normal and the use of the catheter is discontinued. A large amount of residual urine requires further use of the catheter.

This plan has notably decreased the incidence of postpartum cystitis. The retention of urine in the bladder which cannot empty itself is the most potent cause of bladder infection during the puerperium and the careful use of the catheter increases rather than decreases the safety of the woman. Urine is a putrescible fluid and provides a means of growth to the organisms which are present in the bladders of many apparently normal women.

The author,[8] in 1916, investigated bacteriologically the urine of 50 normal pregnant women at term. Urine was obtained by catheter under sterile precautions and received in a series of three sterile test tubes. Cultures were made from the urine in the third tube. Of these 50 cultures 32 showed a pure growth of staphylococcus, in 2 cases a pure culture of colon bacillus was

pears after delivery, at least so far as its clinical evidences are concerned, the changes in the urinary tract which may have been caused by it may remain. Corbus and the author[5] have shown that marked degrees of hydro-ureter and hydronephrosis may persist after the termination of pregnancy. These may require urological attention in order that the ureter and kidney may be restored as nearly as possible to normal.

If the pyelitis which has been present during pregnancy recurs during the puerperium, there may be merely a brief rise of temperature which quickly subsides. Should the pyelitis persist, renal lavage is of great value. It is



A *B*

Fig. 456.—*A*, Hydro-ureter and hydronephrosis. Obstruction at ostium, four months postpartum. *B*, Same case twelve months postpartum showing effect of treatment. (Corbus and Danforth.)

probable that the usefulness of this procedure is due in large measure to the reestablishment of urinary drainage and only secondarily to the effect of any antiseptic which may be introduced.

Infections of the upper urinary tract tend to spontaneous recovery after delivery. Duncan and Seng[11] and Hofbauer[20] have shown that obstruction to urinary flow during pregnancy occurs at the vesical end of the ureter. The obstruction was ascribed by Duncan and Seng[11] to compression of the ureter due to the greatly increased vascularization of the lower uterine segment and parametrium and by Hofbauer[20] to the muscular hypertrophy of

The Body Weight.—A marked decrease of body weight takes place during delivery and the puerperium. The weight of the child, placenta and amniotic fluid, together with the great decrease in the weight of the uterus, in themselves cause a considerable diminution of weight. These factors alone cause a loss of 6 to 6.5 Kg. To this should be added the weight lost through the disappearance of edema, particularly of the lower extremities, by the profuse excretion of fluid through the skin and the kidneys, and the lochia and milk. Heil[18] estimates this further loss at 2000 Gm. The loss in weight during the early part of the puerperium is usually soon replaced and many women tend to gain rapidly later. This is especially due to the taking of more food than is needed, because the mother believes that large amounts of food are necessary to promote a good secretion of milk. This later gain is unnecessary and may be avoided by moderation in diet.

The Reappearance of Menstruation after Labor and the Puerperium.—The time of the reappearance of menstruation has been carefully studied by Ehrenfest[12] who analyzed the histories of 309 labors in 209 women. In 257 of these, all of them women who were normally lactating, menstruation appeared in 132 (51.3 per cent) within twelve weeks after labor. In 130 primiparae included in this group menstruation reappeared within twelve weeks in 52.3 per cent. Of this group of 256 women, 209 (81.3 per cent) menstruated before the child had been weaned, that is, in only 18.7 per cent did the amenorrhea persist through the entire period of lactation. In 199 of these cases nursing continued four months or longer. In 85.9 per cent of these menstruation appeared before the completion of lactation and 14.1 per cent remained amenorrheic throughout the entire period of lactation.

Ehrenfest's[12] conclusions are as follows:

1. In over 50 per cent of all lactating women menstruation reappears within twelve weeks after delivery.

2. In over 80 per cent of all lactations the first menstruation appears before the cessation of lactation.

3. In primiparous women the percentage of those who begin to menstruate before the child is weaned is still larger.

Sundin[36] and Essen-Moeller[13] find respectively that in 37 and 38 per cent of lactating women menstruation returns within eight weeks.

That the reappearance of menstruation is normal and persistent amenorrhea rather the exception seems to be established by the work of a number of observers. Among these are Czerny and Keller,[7] Ponsoye,[31] and Heil.[18] Ehrenfest[12] gives the complete literature.

The belief which is widely held by the nonmedical public that amenorrhea during lactation protects against pregnancy is not justified by facts. Ovulation may occur during amenorrhea and it is possible for pregnancy to take place. It is probable that under the conditions present during the puerperium and the period of time immediately following it, that the uterus is unable to respond by a menstrual flow to the stimulus of a freshly formed corpus luteum. It may happen, however, as Ehrenfest[12] suggests, that with the formation of the corpus luteum the endometrium changes into the premenstrual cycle which is apparently essential for the nidation of an ovum. As ovulation is less likely to occur during lactation, pregnancy is correspondingly less frequent but its possibility must be recognized.

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2. *Asphyxia.*—If gaseous exchange through the placenta is interrupted or decreased, as may happen under certain circumstances when air cannot find its way into the lungs, respiratory efforts are in vain and a condition of suffocation results which is called "asphyxia." The irritability of the respiratory center becomes less acute, and when the child is born respiratory ability is much decreased. The severity of the asphyxia depends largely upon the degree to which the irritability of the center has been reduced. The milder forms go under the name of *asphyxia lividum.* It is characterized clinically by cyanosis, absence of respiratory movements, or their occurrence at long intervals, strong but slow heart beats; muscle tone and reflex irritability are retained and the palatal reflex is present. The more severe cases are called *asphyxia pallidum.* Here there is marked pallor, but the lips are blue, respiratory efforts, if present, are convulsive, the pulse is weak and rapid, muscle tone and reflex irritability are lost and the extremities are flaccid.

Apnea.—When birth has occurred without there having been any previous interference with placental circulation, as in some cesarean sections, for example, there will be an appreciable period of apnea. This is because normal gaseous exchange has not been interrupted previous to the delivery of the child and the concentration of carbon dioxide in the blood is not sufficient to stimulate the respiratory center immediately.

II. **Circulatory Organs.**—The changes that take place in the circulation of the blood after the placental flow ceases and the lungs take over the function of gaseous exchange are probably not as abrupt as we were formerly taught to believe. The excellent investigations of Patten as recorded by him in Chapter XXVII of this text give a new conception of this subject. The inflation of the lungs and the increased capacity of the thorax produced by respiration favor an increased flow of blood through the capillary bed of the lesser circuit. There continues to be a gradual and progressive increase in the volume of the pulmonary circulation, and as a consequence less blood is forced through the foramen ovale and its functional orifice becomes smaller. Final closure of the foramen ovale does not occur for several weeks or months. The gradual obliteration of the ductus arteriosus becomes complete at an average age of eight weeks but may be delayed in certain cases to eight or ten months. When the ductus arteriosus is closed all blood from the right ventricle must traverse the pulmonary circuit and be returned to the left auricle. Before birth the walls of the right and left ventricles are of about equal thickness, the right being slightly thicker. The increased amount of work required of the left ventricle after birth causes its musculature to increase more rapidly until by the seventh year it is at least twice as thick.

III. **Temperature Regulating Mechanism.**—Body temperature is not as stable during the newborn period as it is in later infancy. Following delivery there is usually an initial drop in temperature of from 1 to 2 F., which under favorable conditions returns to normal in a few hours. This thermolability is due to several factors. First, the vegetative nervous system is still quite immature and consequently the vasomotor mechanism is inadequately functioning; second, the heat-regulating center in the medulla is likewise still inefficient; and third, the body surface from which heat is radiated is disproportionately large in comparison to the body weight, *i. e.*, the mass of the

is in the body a superfluous quantity of blood pigment derivatives from which bilirubin will be made. The liver at this stage of maturity is not able to handle all the bilirubin, hence some remains in the blood unchanged by the action of the liver cells. But the liver secretes an abundance of bile that is especially rich in pigment, and a part of this pigment is resorbed through the abnormally permeable intestinal mucosa and finds its way back into the blood stream. There seems to be great individual variation in the functional capacity of the liver. The skin capillaries also vary greatly in their permeability, and this may account for the fact that the intensity of the icterus does not run parallel to the degree of bilirubinemia, and it may also explain the intense and prolonged icterus seen in premature infants, since it is a known fact that increased capillary permeability is characteristic of them.

V. **Digestive Organs.**—The sucking mechanism is well developed at birth and unless there is some anatomic defect of the mouth, or weakness of the muscles, all full term and many premature infants are capable of sucking with sufficient strength to obtain milk. For full information regarding the chemistry of the digestive tract the reader is referred to text-books on pediatrics. In brief, it is sufficient to say that the digestive functions are intact at birth. The intestinal mucosa of newborn infants is more permeable to certain substances than in later infancy. Grulee and Bonar[2] have demonstrated that when certain proteins are fed the blood serum gives specific reactions for these proteins; this does not occur in older infants. In the first two or three days of life the infant's stools are a greenish-black viscid and odorless substance—the *meconium,* which has been accumulating in the intestines from the fourth fetal month on. For the next two or three days the stools are more fluid in consistency, contain flocculent curds, and mucus, and have a yellowish-green color. These transition stools are often passed at quite frequent intervals and one speaks of "transitional catarrh" or *transitional diarrhea.* This condition requires no treatment. When left alone the typical yellow, mealy, breast-milk stools soon make their appearance.

VI. **Urinary Organs.**—Urine is present in the bladder of a newborn infant. How early in fetal life urine is excreted by the kidneys is not definitely known, but it has been found in the bladder of an infant born in the fifth fetal month. Active kidney function does not take place until the child is separated from the placenta. The urine is at first pale but soon becomes darker in color and often, from the second to the fifth day, leaves a yellowish-red or "brick dust" deposit on the diaper; this is called *infarct urine.* The deposit consists of epithelial cells and casts which contain uric acid and urates. The kidneys of infants dying in the first days of life often show uric acid infarcts in the medullary tissues. The amount and concentration of the urine passed are of course largely dependent upon the fluid intake. Usually urine will be passed from two to four times in the first twenty-four hours and with increasing frequency in subsequent days, but it is not uncommon to see an infant that passes no urine in the first twelve to eighteen hours or even longer after birth. This need cause no concern, but if after twenty-four hours no urination has occurred the possibility of some organic obstruction should be considered. Small amounts of albumin are found in a fairly large percentage of newborn infants; the amount usually increases from the second to the fourth day when it gradually subsides and finally disappears entirely not later than the tenth to the twelfth day. Albumin is said by some to be found

CHAPTER XXXI

DISTURBANCES DUE TO DISEASES AND ABNORMALITIES OF THE FEMALE GENITALIA

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The supreme biological function of the normal woman is to conceive, carry to fetal maturity, and bear a healthy child. That she frequently fails in the performance of this function is evidenced by the fact that only about one pregnancy in every four is normally consummated. Aside from the calamitous frequency of self-induced abortion, criminal abortion, and occasional therapeutic abortion, pregnancy is prevented, complicated, and interrupted by various diseases and disturbances of the female genitalia. For the sake of simplicity, a consideration of disturbances due to diseases of the female genitalia, from the standpoint of pregnancy, will be presented under four main classifications:

1. Malpositions.
2. Congenital anomalies.
3. New growths.
4. Pelvic infections.

In this classification it is obvious that more than one of the listed conditions may exist in the pregnant patient at the same time. For example, an infected cervix, a uterine myoma, and a retroverted uterus are not infrequently encountered in the same individual.

MALPOSITIONS

The uterus under normal conditions is a movable organ, and the influences which maintain it in equilibrium are quite complex. It is difficult to define the normal position, but it may be called normal when its body lies parallel with the floor on which the female stands erect. The fundus and cervix should be in the median line, the latter pointing downward and backward toward the coccyx.

Because of its hammock-like supports, the position of the uterus may change easily; many conditions may participate in these changes. Fulness of the bladder above and of the rectum below, inflammatory masses or other pelvic tumors, parturitional injuries, subinvolution, and numerous other pathologic conditions may cause malpositions.

The displacement may assume either a forward or backward, or lateral or upward, or downward direction, or the organ may become axially rotated. Most observers have noted that the normal full-term pregnant uterus is usually found to the right of the median line and presents a certain degree of torsion to the right.

The normally anteverted position of the nonpregnant uterus is increased during the first month of gestation, and as the pregnancy advances the uterus

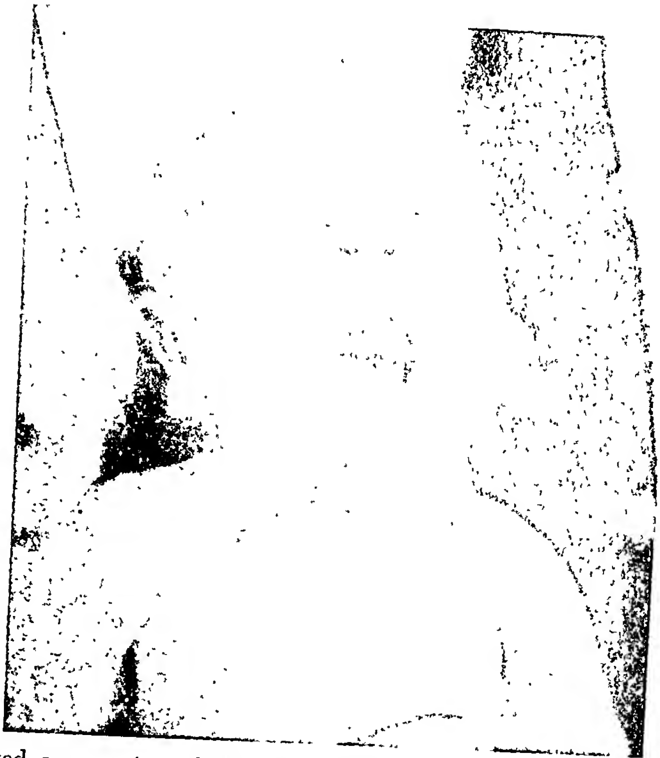

Fig. 459.—Marked asymmetry of the jaws; deep impression of the shoulder under the right ear; marked malocclusion.

Fig. 460.—Reproduction of the probable forced intra-uterine lateral flexion that gave rise to the deformity.

The infant organism remains for a variable period of time under the influence of various ferments, hormones and antibodies taken over from the mother during intra-uterine life. Breast engorgement, menstruation and immunity against certain contagious diseases in the newborn are examples of this peculiarity. The breasts of all full-term infants, both male and female, can be felt at birth as firm rounded swellings varying in size. By the end of the second day, or on the third day, they begin to increase in size and show a gradually increasing engorgement for the following five or six days, after which the swelling subsides. Milk can be expressed from them from the third day on. The whole process corresponds exactly to the phenomenon taking place in the mother's breasts. Some enlargement of the breasts will often persist over a period of weeks and in females I have observed it to continue throughout the first year and longer. In premature infants the breasts are not palpable at birth and they do not become engorged during the newborn period. Lack of palpable breasts at birth, and of subsequent engorgement, is in my opinion the most constant sign of prematurity. The only treatment necessary for engorged breasts is cleanliness and the avoidance of mechanical stimulation from meddlesome manipulations. Mastitis occasionally develops and when it does suppuration is the rule. It is almost always unilateral but may be bilateral. Halban has shown that the uterine mucosa of newborn girls shows changes similar to premenstrual and menstrual changes in women. In a certain number of newborn girls there is slight bleeding from the vagina on about the sixth day or later, which lasts for a few days. It may be enough to stain the diaper and is never profuse.

Immunity to certain contagious diseases, notably to measles, has long been accepted as a peculiarity of the newborn. This is a passive immunity due to specific antibodies transferred to the fetus through the placental blood; this immunity gradually disappears.

Acute or chronic diseases of the mother, either infectious or metabolic, may have an effect upon the development and general health of the newborn. The mother's diet, too, particularly if deficient in certain accessory food factors, is known to affect the health and future development of the offspring.

BIRTH INJURIES

Injuries to the skin are seldom of any practical importance. Lacerations and abrasions, although they sometimes become infected, as a rule heal promptly. Such injuries are usually on the face and scalp, since they are particularly apt to result from the application of forceps. Areas of pressure necrosis in the scalp overlying the parietal bosses may occur as the result of prolonged pressure against a bony prominence of the pelvis. They appear at birth as swellings, dusky red in color and of boggy consistency, except for the center, which is indurated and firm. As the edema subsides there remains after two or three days a firm dark red swelling measuring from 1 to 2 cm. in diameter, which gives the appearance of an abscess. In fact, because of their comparative rarity they are often mistaken for abscesses and are incised. If recognized and left alone a small portion of the scalp overlying the central portion becomes gangrenous, separates and sloughs out, leaving a small punched-out ulcer with a necrotic base. If kept clean and not meddled with, spontaneous healing is complete in from three to four weeks. In milder cases healing may take place without ulceration.

posture.[3] In these cases the shoulder has been firmly pressed against the nerve as it emerges from the stylomastoid foramen and has injured it in this way. One such case was reported by me in which the rounded excavation in the region just below and slightly posterior to the ear caused by the prolonged pressure of the shoulder was plainly seen. Facial paralysis is usually not serious for it clears up spontaneously in the majority of cases within a few days, but may sometimes last several weeks. Occasionally a permanent paralysis results. The condition is evident as soon as the child cries; the muscles on the affected side remain smooth, and the eye on that side remains unclosed; the mouth is distorted, the angle of the mouth on the opposite side being drawn over by the action of the unaffected muscles, while on the paralyzed side it is immobile. The paralysis is almost always unilateral. No treatment is necessary except in rare cases where spontaneous recovery does not take place within a few weeks. Facial paralysis may have a central origin, but when such is the case there are other evidences of damage to the central nervous system.

Injury to the brachial plexus may result from obstetrical procedures as a result of pressure or traction. The paralysis which results is commonly referred to as *obstetrical paralysis*. Manipulative deliveries are much more often the cause than are spontaneous deliveries. Since the injury usually involves the fifth and sixth cervical cords of the plexus, upper arm paralysis (Erb type) is most frequently seen. The arm hangs limply with the shoulder sagging, the upper arm is internally rotated and adducted, while the forearm is slightly flexed and pronated. The muscles of the hand are not affected. Much less frequently there may be injury to the seventh and eighth cervical cords, in which case there is the lower plexus paralysis (Klumpke type). In this the hand and finger muscles are affected. Very rarely there is injury to the whole plexus leading to complete paralysis of the arm. In general the prognosis is favorable. Improvement may become evident even in the first week and complete recovery by the second or third week is the rule. But there are cases in which for several months some paralysis will persist, and in rare instances the paralysis may be permanent. The diagnosis is usually not difficult. Injuries to the shoulder joint can produce symptoms which are quite similar. The treatment consists in keeping the arm in a comfortable position and avoidance of further injury from traction on the cords of the plexus, such as might occur from the weight of the paralyzed arm if it is not supported when the child is handled. When recovery is delayed, the arm should be fixed in a position of external rotation and abduction obtained by means of sand bags or appropriate splints.

Injuries to the peripheral nerves of the lower extremities are extremely rare because of the protected position of the lumbar plexus. When paralysis in this area does occur it is usually the result of intraspinal hemorrhage or damage to the cord itself.

Injuries to the Bones.—The *clavicle* is more frequently fractured during birth than any other bone, but the injury is seldom of any practical significance. There is very little displacement of the fragments as a rule, and healing takes place without deformity. Often its existence is not known until the end of the first week or later, the presence of a swelling due to the callus first calling attention to it. However, signs of pain when the infant is handled may lead to its discovery early. Bandaging the arm loosely against the body with a

may be hindered by an overlying caput succedaneum, but when they do not occur on the same area the two tumors can easily be differentiated by the fact that the caput is not limited by the sutures and has a doughy and not an elastic consistency. Furthermore, the caput tends to disappear rapidly during the first two days while a cephalhematoma tends to increase gradually in size. By the end of the first week a firm ridge can be felt along the border of the tumor, which often gives the impression that the bone forming the floor of the hematoma is depressed. This ridge or wall is formed by the heaped up osteoblastic tissue stimulated into activity by the injury to the periosteum. The tumor usually subsides spontaneously within two or three weeks, but sometimes it persists much longer and the whole periosteal roof develops into a thin bony shell which gradually grows thicker, forming a true osteophyte. A rounded bony protuberance may persist for months but finally levels off to conform with the outline of the growing skull. Any treatment of cephalhematomata is meddlesome and contraindicated except in rare instances when they become infected. If one suspects that suppuration has occurred it is best to aspirate first to confirm the diagnosis, and incise only if the contents are purulent.

Intracranial Injuries.—The most important injuries incident to birth are those which affect the brain. They are important because of the high percentage of deaths they are responsible for in the newborn, and because of the tragic after-effects upon those infants that survive. Undoubtedly some of these injuries are avoidable, but I am convinced that obstetricians have often had much undeserved blame heaped upon them.

Etiology.—Many factors are involved in the production of these injuries, the most important of which will be briefly outlined.

1. The Purely Mechanical Forces Brought to Bear in the Passage of the Head Through the Birth Canal.—The effect of these forces upon the head will vary, depending upon the resistance it encounters in its passage and the amount of molding necessary, and upon the force of the uterine contractions. As the head is molded to accommodate itself to the shape and size of the pelvis the parietal bones overlap each other and may even overlap the occipital and frontal bones. This puts strain upon the superior longitudinal sinus and upon the tentorium, under which veins emptying into the longitudinal sinus may be torn, and tears may occur in the tentorium with resultant hemorrhage. The bag of waters prepares the way for the head and the time in the course of labor when it ruptures is of great significance in regard to the effects of mechanical forces upon the head.

2. Local Circulatory Disturbances.—Schwartz[4] says that the action of decreased pressure to the presenting part, the cupping action, which causes the caput succedaneum to develop, extends also to the deeper structures, even to the brain. The result is passive congestion in the superior longitudinal sinus extending to the sinus rectus and vena magna galeni and their branches. Venous stasis is produced especially in the veins of the circle of Willis. Hemorrhages or areas of softening are produced in the areas of the brain from which the tributary veins flow.

3. Disturbances of the General Circulation Occurring During Pains.—A condition of "asphyxial stasis" may occur and this stasis makes the blood vessels more susceptible to the effects of the mechanical forces. In breech deliveries probably the combination of general venous stasis and

It has been my practice for quite a few years to give newborn infants a complemental feeding of a one-third milk mixture plus 3 per cent sugar after the first twenty-four hours and until breast feeding is adequate. My impression is that the following things have been accomplished: Fewer infants have transitory fever; they nurse more vigorously at the breasts instead of less vigorously, as some authorities still contend, and thus maximum function of the breasts is more rapidly attained; the danger of great initial loss of weight in case the mother's breasts are slow in functioning is much reduced, and the number of infants going home from the hospital without having regained their birth weight has become much smaller. Whether or not this latter point is of any practical importance to the infant it surely is a factor which contributes to the peace of mind of the mother and thus helps her to recover her normal nervous and mental equilibrium. So if no bad effects on the child can be proved to be due to early complemental feeding, the advantages mentioned seem to me sufficient to recommend it.

The mother's breasts usually become engorged by the third day after delivery and true lactation begins. In some cases active milk production begins as early as the second day, and not infrequently is delayed until the fourth or fifth day and in rare cases even until the end of the first week. Until this time only colostrum or colostrum plus a small amount of milk is obtained from the breasts. There is good reason to believe that the colostrum is of value to the infant, therefore regular nursing at the breasts is started as early as six hours after delivery, and is repeated every six hours through the first day and after that every four hours. After lactation really begins, putting the baby to the breasts at regular intervals is necessary for the proper functioning of the breasts as well as for the purpose of relieving their engorgement. Proper stimulation, of the breasts, so essential for their adequate functional activity, is best accomplished through the vigorous nursing of the infant at regular intervals. For the average full-term infant it is sufficient that he be put to the breast every four hours. While there are undoubtedly individual instances where more frequent nursings are advisable the great majority of full-term infants probably do better on a four-hour nursing schedule. The question now arises, how many nursing periods should there be in the twenty-four hours? My answer is six. I am well aware that in many, probably in the majority, of our best hospitals the infants are allowed to nurse at the breasts only five times a day, that is, they are not nursed at 2 A. M. The argument in favor of this procedure is that to nurse the baby at this hour would interfere with the mother's rest, and that she needs this rest more than the infant needs the food, and besides, the baby can be given a bottle in the nursery if necessary. I do not believe this is a valid argument in most instances. The discomfort the mother experiences from her painfully engorged and unrelieved breasts interferes with her rest much more than does being disturbed to nurse her baby. The breast which was emptied at the 6 P. M. nursing has to wait until 6 A. M. to be relieved again and the one emptied at 10 P. M. must wait until 10 A. M. And this brings up another argument against this practice, *i. e.*, proper functioning of the breasts is handicapped by these long lapses without stimulation. I have seldom had a mother object to nursing the baby at 2 A. M. when these facts were presented to her, and almost without exception she has said that she actually rested better than when permitted to omit that feeding.

Barrett states that in the presence of ovarian tumors at the onset of pregnancy, we have 2 patients with one pathologic condition, rather than one patient with two pathologic conditions; and he makes a plea for greater consideration of the child in utero and advises removal of the pathologic condition and not the ovum. In general there can be no disagreement among obstetricians with this opinion. The tolerance of the pregnant uterus to the removal of such tumors, without abortion, is well known; to inhibit uterine cramps it is wise to administer narcotics for a few days after the operation.

When a benign ovarian tumor is known to be present during pregnancy, careful prenatal observations should be made, as advised in the care of cases with uterine fibroids.

The majority of the smaller tumors need not be disturbed.

Malignant tumors of the ovary, while rare, are always serious complications of pregnancy and demand radical treatment.

Fig. 505.—Solid carcinoma of ovary.

The author, in 1928, had a most unusual case of malignant tumor of the ovary in a woman, age twenty-one years, who had been married two and a half years. She came because of sterility. An examination revealed a large, hard, irregular tumor which filled the entire pelvis and extended upward as far as the umbilicus. The uterus was retrocessed and was lying under the tumor. Operation revealed a solid tumor of the right ovary, the size of a child's head. Pathologic examination showed it to be an adenocarcinoma (Fig. 505). This was the largest completely encapsulated, malignant tumor of the ovary that the author had ever observed. The patient was given contraceptive advice for a year and a half after the operation, at the end of which time she became pregnant and gave birth to a living child. Mother and child are now in excellent health.

Over 200 cases of malignancy of the fallopian tubes have been reported.

acholic stools is a different condition, and is usually due to congenital atresia of the bile ducts. When intense icterus first makes its appearance in the second or third week, it belongs to a different category, for it is almost always of septic origin.

Hemorrhagic Disease of the Newborn.—There is still another peculiarity of the newborn that may overreach physiologic limits and become a large factor, if not the chief one, in the etiology of a condition which interferes with normal progress in the newborn period. We have reference to the increased coagulation and bleeding time of the first week of life, and the condition known as hemorrhagic disease of the newborn. This condition differs from hemorrhagic diseases in later life, for then there is either a permanent hereditary diathesis, or a disease condition of which hemorrhage is simply a symptom, while here we are dealing with a temporary condition peculiar to the newborn which, if the child survives, will never recur. Hemorrhage during the newborn period is favored by peculiarities of the vascular system as well as those of the blood, namely, congestion and hyperemia associated with birth, asphyxia, and greater permeability of the vessel walls, especially in the premature. Why decreased coagulability should be a peculiarity of the first days of life has not yet been determined. The general conception is that there is a disturbance of balance between the substances concerned in coagulation, but the agents which cause this disturbance are unknown. Under pathologic conditions, the coagulation time is prolonged in extreme cases to one half hour and longer; there are, however, not a few cases in which coagulation and bleeding time show no essential variation from normal.

In this disease, hemorrhages may occur in almost any tissue of the body —mucous membranes, skin, parenchymatous organs, serous membranes, etc. The most common, and from a practical standpoint the most important, are hemorrhages of the gastro-intestinal tract, the umbilicus, the mucous membranes, the skin, the suprarenals, and the brain and meninges.

Melena neonatorum is the name used to designate hemorrhage from the gastro-intestinal tract. The onset is usually on the second or third day, seldom earlier, but may be as late as the fourth day. The first symptom may be vomiting of blood, and shortly thereafter, passage of bloody stools, but hematemesis may be entirely lacking, and blood in the stools the only symptom. Masses of clotted blood may be passed in large quantities three to six times a day. Under treatment, the stools become less bloody and lighter in color, and return to normal appearance in from one to three days. The actual loss of blood is often considerable, and the child becomes quite anemic. In the more severe cases and the malignant types where the coagulability of the blood has been more seriously affected, the blood in the stools and also in the vomitus is fluid blood, and exsanguination may occur rapidly unless adequate treatment is instituted immediately. Some of these cases die in spite of early and intelligent treatment. Bloody stools seen later in the newborn period are usually associated with hemorrhages elsewhere in the body, and the infant appears otherwise sick. These are usually cases of sepsis with hemorrhagic symptoms. Hemorrhagic symptoms of congenital syphilis belong to this group. Blood not originating from the gastro-intestinal mucosa is sometimes vomited or passed in the stools. In such cases the blood has been swallowed, and may have its origin from nasal hemorrhage or from

taneously. In many of the benign cases it is probable that recovery will take place without any treatment, but the spectacular manner in which hemorrhage stops when blood has been injected is sufficient recommendation for its use in every case of hemorrhagic disease. In the malignant types, even such treatment may not avail, but certainly many lives have been saved where the condition seemed hopeless.

Prematurity.—The clinical behavior of a newborn infant depends in no small degree upon the state of maturity to which it has developed at the time of its birth. The maturity of the organism, while largely a matter of the duration of its intra-uterine life, is influenced as well by other factors which may interfere with the intra-uterine growth of the fetus. From an obstetrical viewpoint, therefore, an infant may be born at term, but still exhibit unmistakable evidence of being immature. It is important for the child that its immaturity be recognized in order that it receive the kind of care it needs. The simplest and probably the most practicable plan is to consider, as Yllpö[8] does, that all infants weighing less than 2500 Gm. at birth are immature, and treat them accordingly. It is well to keep in mind, however, that some mature infants may weigh less than this amount, and that some obviously immature ones may weigh more. Thus classified, about 10 per cent of all infants born alive are immature, and it is worthy of note that from one fifth to one third of these are twin infants. The cause of premature birth is unknown in the majority of cases. Accidents to the mother and deliberate interruption of pregnancy by the physician account for a small percentage. Contrary to a common notion, syphilis is to blame in probably less than 4 per cent; even the French statistics give syphilis as a cause in not more than 10 to 12 per cent. Of the known causes, twin pregnancy is the most common one.

The mortality of premature infants is high; 30 to 60 per cent die within the first year. The two main considerations in this mortality are the state of maturity of the infant and the cause of the prematurity. The following instructive figures are taken from Yllpö's statistics: Of 37 infants with a birth weight of 600 to 1000 Gm., 72.9 per cent died within the first five days, and barely 5 per cent lived to be a year old; of 183 weighing 1000 to 1500 Gm., 31 per cent died within the first five days, and 60.6 per cent were dead by the sixth month; of 240 with a birth weight of 1500 to 2000 Gm., 10.8 per cent died in the first five days and 34.5 per cent in the first six months; and of 208 weighing 2000 to 2500 Gm. at birth, only 4.8 per cent died in the first five days, and at six months the mortality was 23.1 per cent. From this it is evident that in giving a prognosis, consideration of the birth weight is important, but one is not justified in being altogether pessimistic about the chances of even the very small ones, for they sometimes survive and do quite well.

Signs of Prematurity.—In addition to small size there are certain physical peculiarities which most prematures exhibit. Of these the most common are: very slight deposit of subcutaneous fat; abundant lanugo; lack of cartilaginous firmness in the lobes of the ears, so that they lie against the head like soft fleshy flaps; in females, prominent labia minoris and clitoris, and in males testicles not in the scrotum; fingernails and toenails not reaching to the ends of fingers and toes (this is an extremely variable sign); and lack of breast engorgement. Of these the only one that can be considered truly pathogno-

turity, also contributes to the condition. In premature infants secondary atelectasis is quite common; inflation following the beginning of respiration is usually very complete, but on account of the immaturity of the capillaries and the permeability of their walls, the interstitial tissues and the alveoli themselves soon become filled with fluid and large portions of the lungs are so edematous as to be functionally inactive. The treatment of these attacks of asphyxia is urgent, but must be carried out with the least possible handling, and with the greatest conservation of body temperature. Skin stimulation by immersion in warm water, and sprinkling cold water on the chest while the rest of the body is immersed, is probably the best method when there is complete apnea. If there are occasional respiratory movements, inhalations of oxygen or a mixture of oxygen and carbon dioxide will often give good results. Good results have also been reported in cases where no respiratory movements or only very shallow ones are being made by introducing

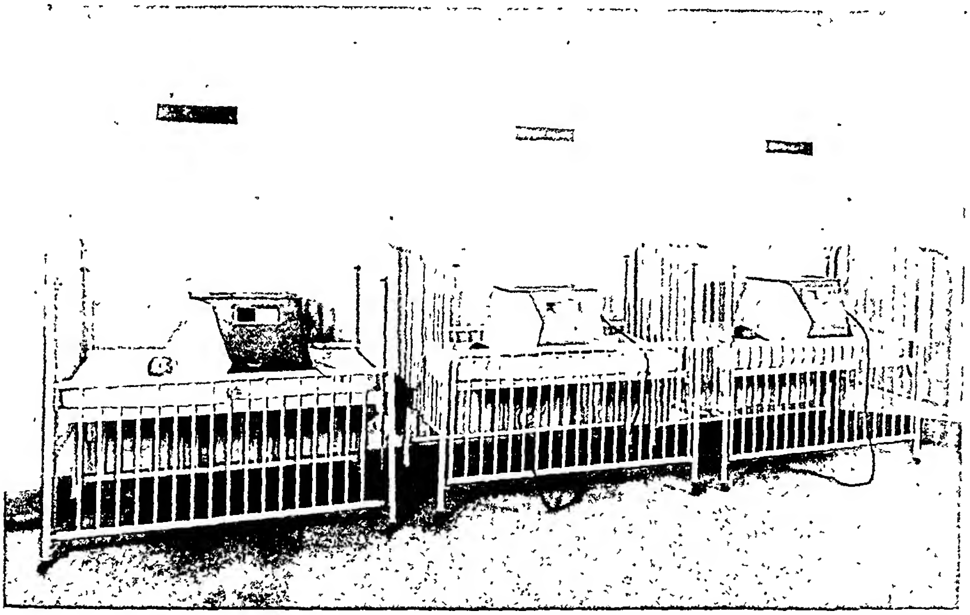

Fig. 461.—Incubators for premature infants in use at the Presbyterian Hospital of Chicago.

oxygen into the esophagus or stomach by means of a small catheter, the oxygen being quickly absorbed through the mucous membranes. In every newborn department, an oxygen tank is essential.

Care and Feeding.—Whenever possible premature infants should be cared for by a special nursing personnel. In the general care and feeding of these infants, more depends upon the type of nursing care they receive than upon all the other details of their management combined. Successful management depends upon accurate attention to maintenance of body temperature, proper meeting of the nutritional requirements, and avoidance of infection. With responsible and intelligent nursing, body temperature can be properly maintained by the use of hot-water bottles. Many different types of incubators have been devised for this purpose, and some hospitals are equipped with incubator rooms. Most incubators are quite complicated and expensive, but excellent results can be obtained by using simpler devices. The

five days when a further increase in the amount given by tube to $1\frac{1}{2}$ ounces is made, and in the amount given by dropper to $\frac{1}{2}$ ounce. Thus by the tenth to twelfth day, the baby is getting 12 ounces a day. If the gain in weight is not satisfactory, the breast milk may be concentrated by boiling it down to three fourths or two thirds its volume, so that without increasing the amount of fluid, the total calories can be increased. There are other methods that are no doubt equally satisfactory, but this schedule has given good results in the author's hands. Strict asepsis is imperative in the care of premature infants.

CONGENITAL AFFECTIONS AND EXTRA-UTERINE ACQUIRED DISEASES

No attempt will be made to discuss any but the more important and common conditions that would come under this heading.

The Umbilicus.—When the skin extends an unusual distance onto the umbilical cord, an excessive skin stump is left after the amniotic portion sloughs off. This is known as an *umbilicus cutis*, or skin navel, and is of no importance except that it is sometimes mistaken for an umbilical hernia.

Fig. 463.—Umbilicus amnioticus as it appeared on the third day.

When the amniotic portion of the cord spreads out over the umbilical ring, sloughing of the cord leaves a small defect on the skin surface of the abdomen which heals over, and this condition is called *umbilicus amnioticus.* An exaggeration of this anomaly results in a hernia into the cord, which rare condition is usually fatal unless immediate surgical repair can be done.

Diseases of the umbilicus constituted a large chapter in the literature concerning the newborn before the universal application of aseptic technic, but today the clinical course of the healing of the umbilical wound is usually quite uneventful. The possibility of infection with pathogenic organisms is, however, always present and general sepsis may be the result of such an infection. Periarteritis is what usually occurs as a forerunner of general sepsis,

medial surfaces of the extremities are not involved to any extent. The condition is present in a large majority of infants of the Mongolian race, and in at least half of those of the negro race; it is also found in the Mexican Indian and in other dark-skinned races. Where there has been an admixture of negro or Mongolian blood, these spots may be found on offsprings of the white race. However, a few cases have been reported in pure Caucasians. It is undoubtedly an atavistic phenomenon. The color is due to special pigment cells in the deep layers of the corium. The discoloration usually disappears by the third or fourth year, but may persist.

Infectious Diseases of the Skin.—In spite of the strictest aseptic technic, infections of the skin will occur from time to time among the newborn. While usually only isolated cases occur, it not infrequently happens that the infection spreads to several infants and an epidemic is threatened. Super-

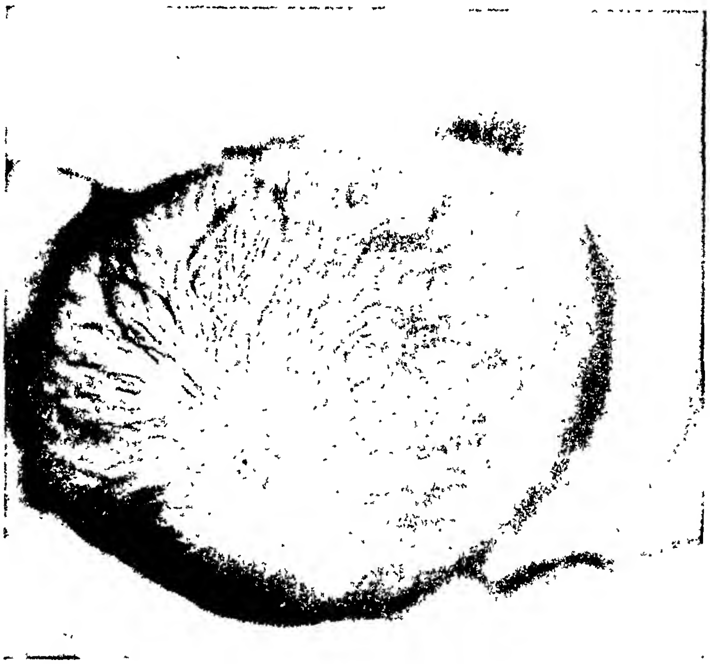

Fig. 466.—Typical congenital skin defect.

ficial *pus infections of the skin* or pyodermias will be discussed here under one heading and no attempt will be made to distinguish between pemphigus neonatorum and impetigo contagiosa bullosa. The lesions are vesicles in the outer layer of the skin filled with thin pus. They may be found anywhere on the body but occur more frequently in the inguinal region, on the flexor surfaces of the thighs, in the axillary spaces, and in the creases of skin on the neck. Often there are only a few isolated lesions but they may be in groups, and smaller ones may coalesce to form larger pustules or bullae. The skin immediately surrounding the pustules is usually slightly reddened. Usually the course is quite benign and no general symptoms of infection are noted, but in true epidemics there may be an occasional case of a malignant type with a fatal outcome. The staphylococcus is usually found in cultures from the pustules. Infants are sometimes born with a few well-developed pustular lesions—congenital pemphigus—the pus from these lesions is usually

wound, from the nose; a tendency for an intense and prolonged icterus; a tendency for severe gastro-intestinal symptoms to occur; and the peculiar temperature reaction so often seen in newborn infections, *i. e.*, an almost complete absence of fever in many cases.

In a chapter of this sort many subjects, such as congenital syphilis, congenital heart defects, and numerous other congenital anomalies and diseases, must be omitted because a short discussion would mean little and they are more appropriate in a pediatric text-book. In conclusion the author wishes to make a plea for the newborn infant, and that plea is that he be given a real physical examination sometime during his newborn period and preferably during the first day. Even the perfectly normal infant presents many interesting characteristics and the physician who becomes familiar with normal infants will be better able to recognize abnormal conditions when they arise. Only by a more thorough knowledge of the newborn on the part of all physicians who have to do with their care will we be able to reduce a death rate which is at present much too high.

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in a later paper (1929) Kellogg[13] has reported oxygen determinations made on blood recovered from both cavae and from both sides of the fetal heart which clearly indicate that the left atrium does not receive, by way of the foramen ovale, unmixed inferior caval blood freshly returned from the placenta.

Indication that the results of these experiments on animals are applicable to the human fetus is given by the work of Patten, Sommerfield, and Paff[22] (1929) on the functional capacity of the foramen ovale. Their study of the interatrial opening in the human fetal heart showed that the apparent capacity of the septal orifice is greatly reduced by the manner in which the valvula foraminis ovalis is attached to the septum. The foramen ovale itself does approximate the size of the inferior caval orifice (Fig. 467). The average of measurements made on forty hearts of full-term, stillborn fetuses showed the caval orifice as 70.5 sq. mm. and that of the foramen ovale as 66.4 sq. mm.

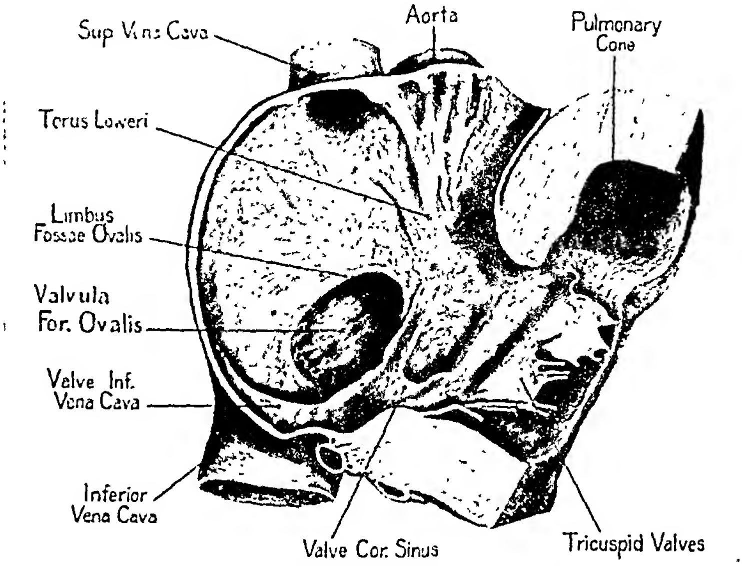


Fig. 467.—Interior of the right atrium of the human heart at birth (× 1½); photograph of a scale model retouched from direct study of a group of normal specimens. (Patten, Sommerfield, and Paff, Anat. Record, vol. 44.)

On casual inspection this creates the illusion that practically the entire inferior caval current could pass through the foramen ovale to the left atrium. The functionally effective interatrial communication is, however, much smaller than the foramen ovale. On the left side of the foramen the valvula is bound down so closely to the septum that the outlet into the left atrium is greatly restricted. Measured in the same forty hearts the orifice between the septum and the valvula (functional orifice, Fig. 468) averaged but 30.1 sq. mm. Put in more easily remembered terms the effective interatrial passage in the heart of a term fetus is a scant half the size of the foramen ovale and little more than 40 per cent of the size of the inferior caval orifice. Even making the forced assumption of a rate of caval inflow sufficiently strong to form a definite current directed at the foramen ovale, this current could not possibly pass through a crooked passage less than half the size of the caval inlet. Eddying back of more than half the inferior caval stream

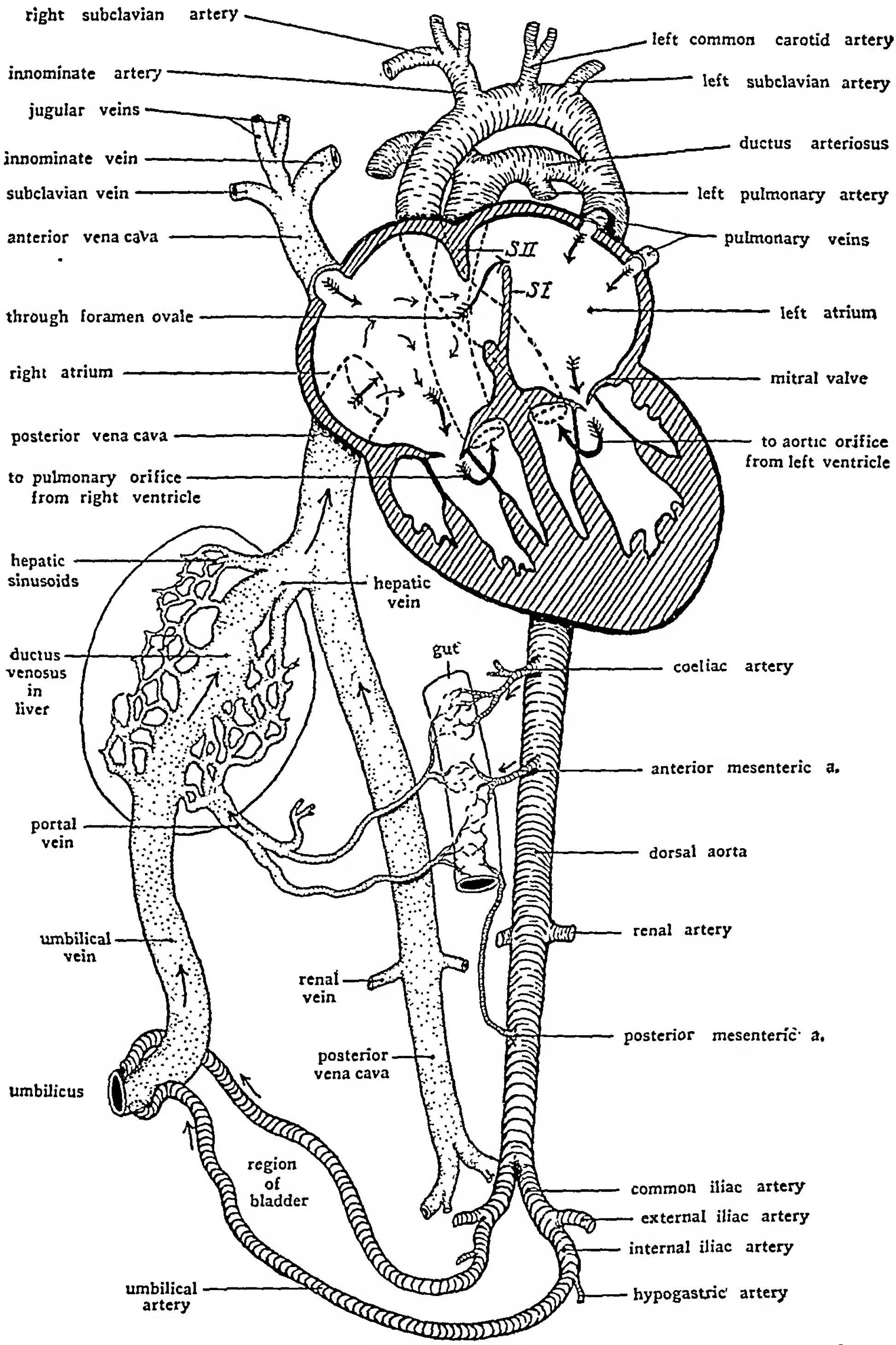


Fig. 469.—General plan of the fetal circulation. For structural details at the foramen ovale see Figs. 467 and 468; for dimensions of the fetal heart see Fig. 470; for estimated relative volumes of main paths of flow see Fig. 471. (From Patten, "Embryology of Pig," published by P. Blakiston's Son & Co.)

lungs, ready at the instant of birth to receive a suddenly rerouted current of blood carried to the lungs for oxygenation. While there are not as yet

right-left balance of cardiac load during fetal life. It does, however, radically lessen, if indeed it does not eliminate entirely, the abrupt increase in pulmonary circulation which it was necessary, on the old basis, to postulate at the moment of birth. Most significant from the standpoint of postnatal changes is the additional fact that the pulmonary arteries are about the size of the umbilical arteries and the total cross-sectional area of the pulmonary veins about the same as that of the umbilical vein. The placental circuit adequately takes care not only of oxygenation, but also of food intake and

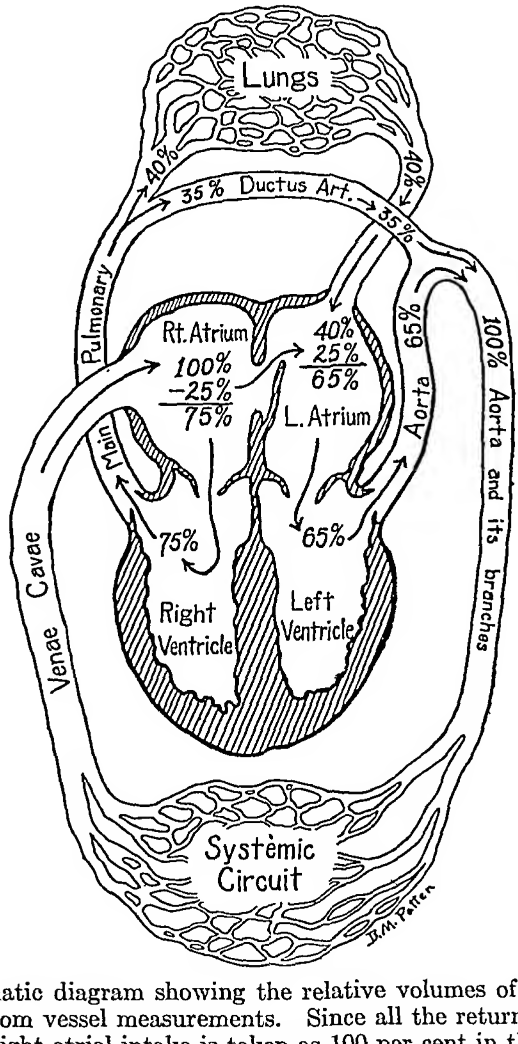


Fig. 471.—Schematic diagram showing the relative volumes of the main circulatory routes as estimated from vessel measurements. Since all the returning blood must enter the right atrium the right atrial intake is taken as 100 per cent in this empirical approximation.

waste elimination. If, therefore, the pulmonary vessels are carrying a circulation in any way consonant with their size there is enough blood already going to the lungs before birth to care for oxygenation as soon as the lungs are ventilated.

Figures 469–471 summarize graphically the points discussed above and indicate the revisions in the current interpretation of the fetal circulation that are entailed. There is mixing of the blood in the right atrium instead of crossed "pure" currents. The restricted functional orifice of the foramen

If these figures are functionally significant, the ratio of blood received by the two ventricles should equal both the ratio of right to left ventricular weight and the ratio of pulmonary to aortic outlet. Substituting the figures obtained from actual heart measurements:

$$\frac{79}{69} \text{ should equal } \frac{8}{7} \text{ : Correlation computes at 0.98}$$

And:

$$\frac{79}{69} \text{ should equal } \frac{35}{29} \text{ : Correlation computes at 0.94}$$

These methods of comparison are of course crude from the mathematical standpoint and quantitatively the results should be regarded as tentative. When pressure measurements and flow determinations can be added to the available evidence more critical mathematical methods must be applied to the problem. Pending this time, the existence of a roughly 8-to-7 relation between (1) right and left ventricular intakes as estimated empirically from the measurements of vascular orifices, (2) right and left ventricular weights, (3) right and left ventricular capacities and (4) pulmonary and aortic outlets may be regarded as indicative of the nature of the right-left functional balance in the fetal heart.

Because the Sabatier idea of crossed blood currents in the fetal right atrium has been so long intrenched, the conception that there is mixing of the blood in the right atrium will probably arouse more automatic objection than either the idea of a prenatal pulmonary circuit of considerable volume, or the conception of the right-sided preponderance of the fetal heart. Such a mixing of the blood may seem inefficient compared with conditions in the adult, but this is a one-sided comparison. The fetus is an organism in transition. Starting with a simple ancestral plan of structure and living an aquatic life, it attains its full heritage but slowly. It must be viewed as much in the light of the primitive conditions from which it is emerging as in comparison with the definitive conditions toward which it is progressing. Below the bird-mammal level, circulatory mechanisms with partially divided and undivided hearts and correspondingly unseparated blood streams meet all the needs of metabolism and growth. Maintenance of food, oxygen, and waste products at an average level which successfully supports life does not depend on "pure currents," although such separated currents undoubtedly make for higher efficiency in the rate of interchange of materials. From a comparative viewpoint, the fact that the mammalian fetus is supported by a mixed systemic circulation seems but natural. Moreover, if the fundamental competence of such a circulation is emphasized rather than the respects in which it falls short of the perfected adult mechanism, we are not forced to postulate a series of abrupt and profound changes in the circulation at the time of birth, nor are we continually puzzled by the "seemingly impossible size" of septal defects such as are not infrequently carried without serious handicap into maturity and even old age.

THE POSTNATAL CHANGES IN CIRCULATION

The changes occurring in the circulation following birth must be reevaluated in the light of this new conception of the fetal circulation. According to the traditional interpretation, tying the cord reduced the volume of

ovalis by carrying out, simultaneously, intravenous infusion into a tributary of the superior cava and venesection in the territory drained by the inferior cava.

As to the ductus arteriosus being abruptly occluded by traction on it incident to the first inspiration, a little dissection and some experimental manipulation of that tough-walled vessel will make one exceedingly skeptical. Furthermore, in case after case of congenital aortic stenosis the ductus arteriosus remains open, pouring a supplementary stream into the deficient aortic current. Conversely, in cases of true congenital pulmonary stenosis the ductus quite commonly remains open with blood from the aorta going through it to the lungs in reverse of the normal direction of fetal flow. If in such experiments, obligingly performed for us by nature, complete inflation of the lungs fails, over a period of months or even years, to effect the closure of a ductus arteriosus which is carrrying merely a supplementary blood current from a more or less crippled heart, how can we look to such a mechanism to close off abruptly, at the moment of birth, a blood stream equal in power and volume to that of the isthmic part of the fetal aortic arch? (See Fig. 472.)

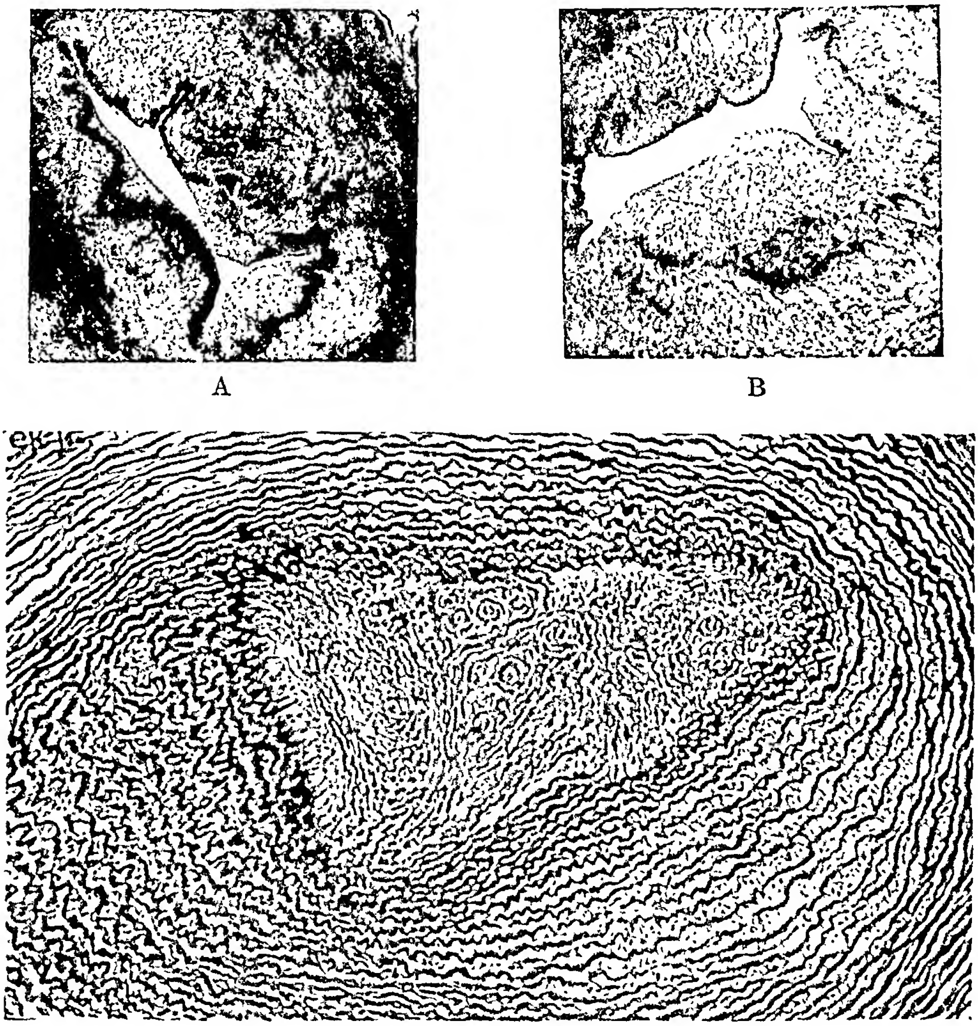
The idea that the pulmonary flow is negligible before birth and rises abruptly to full power with the beginning of respiration is, as far as a diligent search of the literature reveals, pure dogma. As was stated above, no direct observations have been made on the volume of the pulmonary flow before birth, but the circumstantial evidence, first of the size of the vessels and second of the right-left unbalance that would exist in the fetal circulation if these vessels were not operating at capacity, strongly indicates that the pulmonary circuit before birth is a dynamic factor which cannot be ignored. But, although the pulmonary vessels are equivalent in size to the umbilical vessels, the total cross-sectional area of the pulmonary veins at the time of birth is approximately only one third of the total cross-sectional area of the veins entering the right atrium (Fig. 470). It entails an incredible series of assumptions to juggle pressures and rate of flow in such a manner as instantaneously to balance the output of one group of veins against the output of another group having three times their bore. Yet precisely such assumptions are demanded by the theory that an immediate closure of the valvula foraminis ovalis is brought about by prompt equalization of left and right atrial pressures.

The existence of doubt concerning, or positive evidence against, each separate event in the chain of happenings invoked to throw the switches for an immediate and radical rerouting of blood at the time of birth should give us pause. Is not the very existence of such abrupt changes as unsupported as the elaborate series of occurrences supposed to explain them? Let us look without preconceived prejudice at the possibility that the changes in the circulation following birth are accomplished gradually and without abrupt rerouting of major blood currents.

The fact that, even though it is much greater in volume than has hitherto been recognized, the pulmonary circuit at birth is relatively still considerably smaller than it is in an adult, does not seem to offer any great difficulty. In the first place, it is of the same order of magnitude as the placental circuit, which has been caring for not only gaseous interchange but also food intake and waste elimination. In the second place, the high red cell count and the

must depend upon the progressive increase of pulmonary return to the left atrium. All these conditions suggest that the readjustment of the circulation spreads over a period of at least a month following birth.

Because the most striking differences between fetal and adult circulations center about the ductus arteriosus and the foramen ovale their postnatal



A B

C

Fig. 473.—Histologic changes involved in the closure of the ductus arteriosus. A, From an infant twenty-one days after birth. Note the padlike thickenings of the intima. B, Infant thirty days after birth. The more open condition of the lumen as compared with A is probably an accident of preparation. Note that the potential lumen as indicated by the perimeter is greater in the younger specimen. The progress of occlusion is clearly indicated by the markedly increased thickness of the intima. C, Weigert picrofuchsin preparation of the recently closed ductus of a pig. This specifically stained preparation shows the important part played by elastic tissue in the intimal thickening which progressively occludes the ductus. (Schaeffer, J. P., Jour. Exp. Med., vol. 19, 1914.)

changes must be scrutinized in detail. The closure of the ductus arteriosus depends not on any sudden traction or kinking but upon slow histologic changes resembling those of endarteritis obliterans (Fig. 473). Commencing at the time of birth there is a progressive reduction in the bore of this vessel

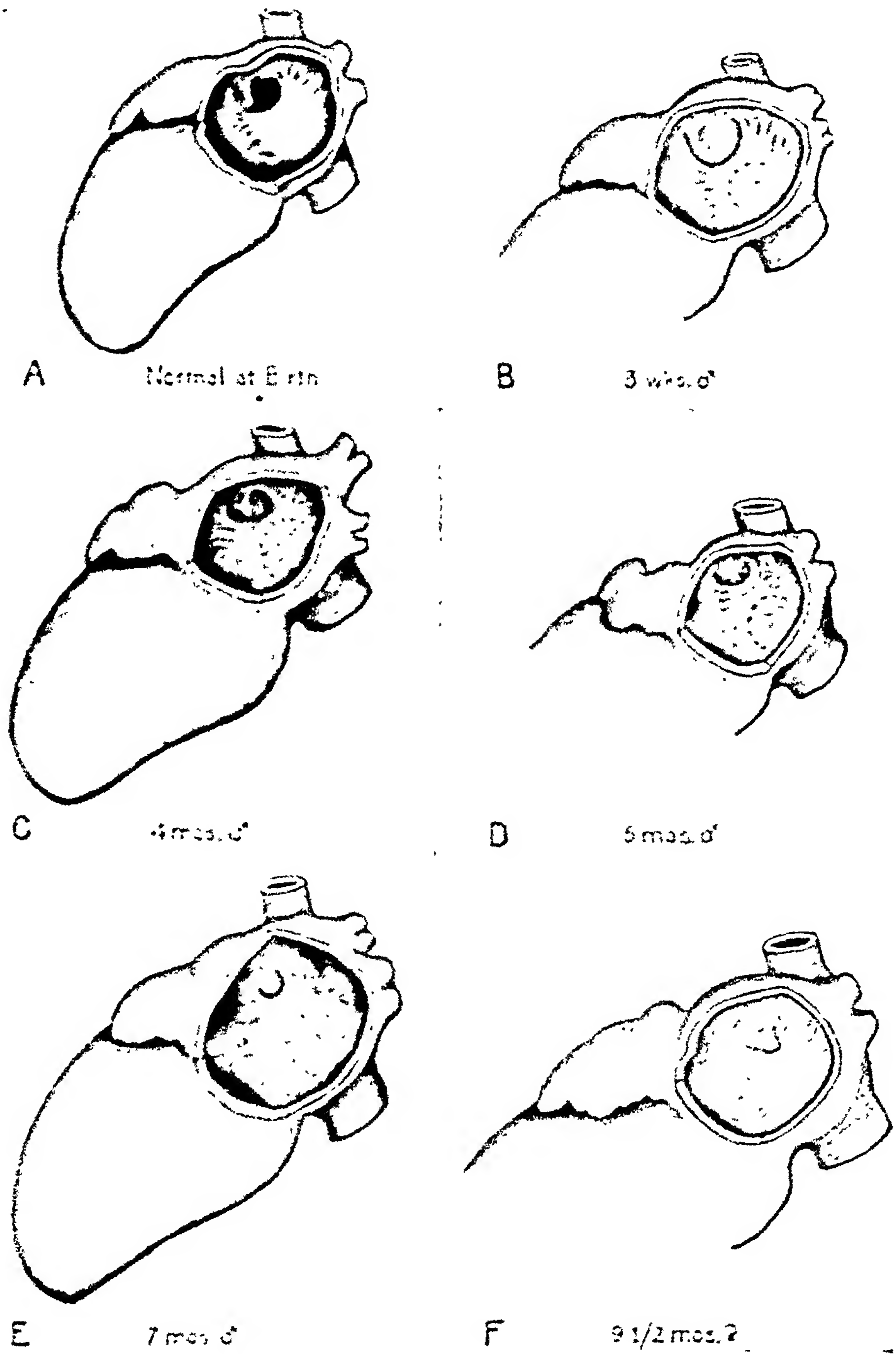


Fig. 471.—Drawings of hearts (× ½) with left atrium opened to show the gross changes in the valvula during the period of the closure of the foramen ovale. Compare with Fig. 476 showing the microscopical changes. (Patten, Amer. Jour. Anat., vol. 48.)

atrium in a position which suggests the influence of the prenatal blood flow from right to left (Fig. 468). This characteristic fetal configuration is lost slowly during the first four to six weeks after birth and the valvula comes to lie more and more closely against the septum (Fig. 474). Measurements

valvula. The significance of these changes seems plain. The gradual decrease in the size of the functional orifice of the foramen ovale during the first six to eight weeks after birth implies its gradual abandonment as an equalizing channel between the atria concurrently with the decrease in bore of the ductus arteriosus and the increase in pulmonary circulation. Here again there is virtually the same readjustment period. The subsequent characteristic histologic change in the valvula foraminis ovalis chronicles morphologically its conversion from a movable flap into a fixed partition.

The way the abandonment of the foramen ovale follows step by step the decrease in ductus current and the concomitant increase in pulmonary circulation clearly indicates that a marked delay in the postnatal reduction of the functional orifice of the foramen ovale should be regarded, not as a

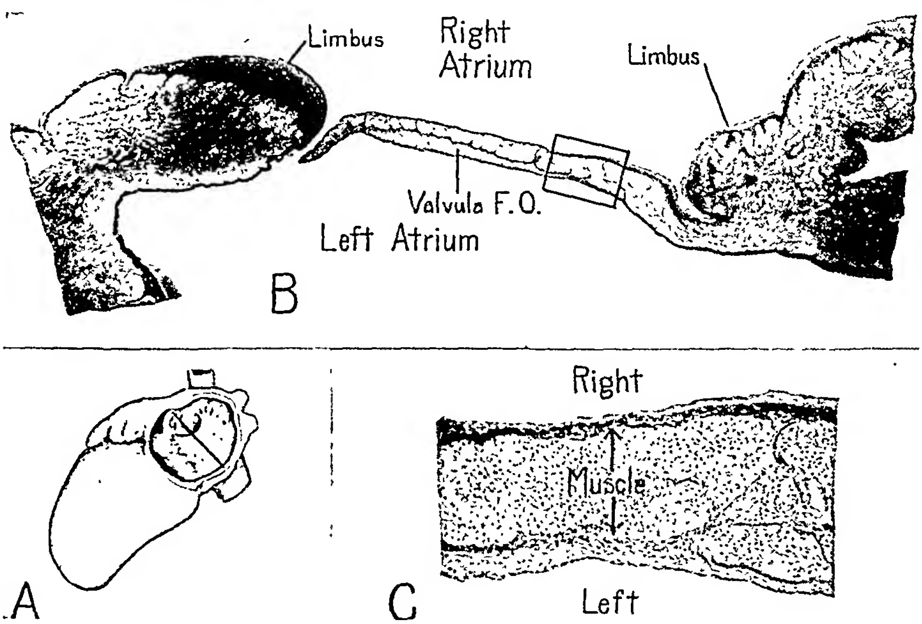


Fig. 475.—Photographs showing the location of the sections illustrated in Fig. 476. The line in A indicates the plane of sectioning with reference to the heart as a whole; B shows the topography of the sections as seen in low magnification; and C, a more highly magnified portion of the section located by the rectangle in B. (Patten, Amer. Jour. Anat., vol. 48.)

cause of circulatory incompetence, but as a result of failure successfully to attain the new functional equilibrium characteristic of postnatal life. Such delay occurs most strikingly in cases of true congenital pulmonary stenosis. Practically without exception, such individuals, even if they live many years, exhibit a valvula foraminis ovalis no more tightly bound down to the septum than it was during the fetal period.

Complete adhesion of the valvula, to become an integral part of the interatrial septum, comes as a culmination of the period of connective tissue proliferation. There is great individual variability in the age at which this final step in the obliteration of the foramen ovale occurs. A usual range, rather than a specific age, is all that can be stated. The usual time of complete anatomical closure is certainly not earlier than the last third of the

TABLE 3

RECORDS OF VARIOUS OBSERVERS OF THE TIME OF COMPLETE ANATOMICAL CLOSURE OF THE FORAMEN OVALE*

Observer.	Period of functional closure.		Period of thickening of valvula and beginning of adhesion.		Period of adhesion ← (anatomical closure) →	
	First 2 weeks.	15 days to 6 weeks.	6 weeks to 3 months.	3 to 6 months.	6 months to 1 year.	Over 1 year (early childhood).
Alexeieff, 1900[2]	10	38	71	68	18	2 (1–5 years)
	(0)	(0)	(4)	(6)	(3)	(2)
Alvarenga, 1869[3]	63	78	35	18	5	12 (1–5 years)
	(0)	(0)	(2)	(1)	(0)	(4)
Patten, 1931[21]	106	12	7	9	13	9 (1–2 years)
	(0)	(0)	(0)	(0)	(2)	(7)
Hinze, 1893[10]	Examined 50 cases during first year. Found adhesions beginning in last half of year. No cases of complete closure until second year.					43 (1–12 years, mostly under 5 years) (19)
Total examined	179	128	113	95	36	66
Total anatomically closed	(0)	(0)	(6)	(7)	(5)	(32)
Percentage anatomically closed.	0	0	5	7	14	48

* The upper number in each space is the number of cases examined. The lower number, enclosed in parentheses, is the number of cases showing complete anatomical obliteration.

The 667 cases included are taken from four consecutive series of observations in which the condition at the foramen ovale was the primary subject of study. No data have been included from articles based on second-hand tabulation of routine autopsy protocols, from small or discontinuous series of observations, or from papers leaving doubt in the reader's mind as to whether the "closures" recorded were complete anatomical obliteration of the passage or merely functional closures.

TABLE 4

RECORDS AS TO COMPLETENESS OF CLOSURE OF FORAMEN OVALE AFTER EARLY CHILDHOOD. GROUPED ACCORDING TO AGE AS FAR AS DATA PERMIT

Observer.	5–20 years.		Over 20 years.		Over 40 years.	
	Examined.	Closed.	Examined.	Closed.	Examined.	Closed.
Alexeieff, 1901[2]	2	2				
Alvarenga, 1869[3]	2	1				
Bizot, 1837[4]	34	23	121	89	63	49
	(1–15 years)		(over 16 years)			
Brit. Anat. Soc., 1898[12]	39	30	286	217		
Fawcett and Blachford, 1900[7]	6	3	299	207		
Hinze, 1893[10]	43	19	359	277		
	(1–12 years)					
Ogle, 1857[17]	..	..	62	49		
Rostan, 1881[27]	50	33	561	439	357	277
	(0–20 years)					
Wallmann, 1859[35]	..	..	300	170		
			(mostly 20-30 years)			
Total	55	36	1988	1448	420	326
Percentage closed	..	65*	....	72.8	...	77.6

* If the records of Bizot, Hinze, and Rostan which take in some cases from the first five years are included, the totals are: 176 examined, 111 closed = 63 per cent closed.

closure has been neglected. There seems now to be sufficient evidence furnished, not only by the changes at the foramen ovale itself, but also by the diverse group of closely interrelated changes discussed above, to place the time of functional closure with fair accuracy. All the primary readjustments appear to be fairly well accomplished by the end of the first month or six

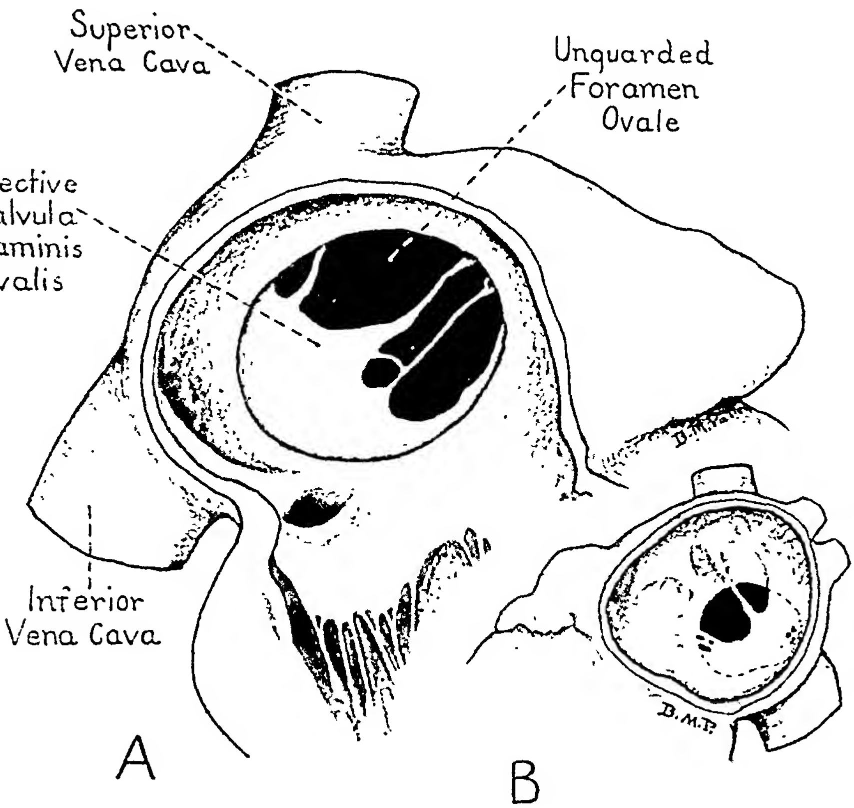


Fig. 478.—Examples of congenital defects in the structure of the valvula foraminis ovalis which make either functional or anatomical closure impossible. Such defects should be sharply differentiated from mere probe patencies (Fig. 479). A, Right atrial aspect of heart of woman fifty-two years old, drawn from specimen No. 3027 in the Museum of the Pathologisch-anatomisches Institut, Vienna. Case described by Rokitansky ('75, p. 52), but not illustrated. No clinical history ("sanitätspolizeilich secirt"). Pulmonar ythrombosis found at autopsy was the immediate cause of death. The tremendous enlargement exhibited by this heart is characteristically present with large interatrial defects and is presumably compensatory to the functional handicap imposed by the defects. The fact that the individual lived to this age as a laboring woman shows what surprisingly extensive interatrial defects may be compensated and carried into maturity or even old age, provided there is no intercurrent disturbance elsewhere in the cardiovascular or pulmonary mechanism. B, Left atrial aspect of heart of six-weeks-old female infant with defect similar to that shown (A) in adult heart. Autopsy No. 176,258, Path. Inst. Wien. Cause of death, enteritis. (Patten, Amer. Jour. Anat., vol. 48.)

weeks after birth. The lungs are completely inflated, the red cell count and the hemoglobin index are about at adult levels, the lumen of the ductus arteriosus is reduced to almost nothing, and the valvula foraminis ovalis has been pulled tight across the foramen and close against the septum.

has been closed or at least greatly reduced. Consequently it is usually about three months after birth before the isthmus loses its fetal configuration (Fig. 472).

Last of all the postnatal changes to be accomplished is the building up of the left ventricular musculature. The factors which initiate the increase in the weight and power of the left ventricular wall become operative when the new functional balance is established in the heart with the actual closure of the ductus arteriosus and the functional closure of the foramen ovale. In the fetus with its open ductus arteriosus the load of the systemic circuit was shared by the right and left ventricles, and their muscular walls were of about the same thickness, although the total bulk of the right ventricle was a little greater because of its slightly greater capacity. By three to four months after birth the weight of the left ventricular musculature overtakes that of the right in response, first, to the progressively increasing return from the lungs; and then, as the ductus arteriosus becomes closed, in response to the assumption of the entire pumping load of the longer systemic circuit without the aid of the right ventricle. Continuing to react to these changed conditions the left ventricular weight climbs steadily above that of the right, until its full adult degree of preponderance is reached somewhere around the seventh year (Müller,[16] 1883; Gross,[9] 1921).

SUMMARY

With full recognition that until pressure determinations are available for the fetal and neonatal circulation the evidence is incomplete, it can nevertheless be stated that all the data now available point to the conclusion that the changes in circulation following birth are gradual rather than abrupt. As nearly as it can be outlined at present, the transition from fetal to postnatal circulation occurs as follows.

At the close of embryonic life the pulmonary circulation has attained sufficient volume so that it can care for oxygen intake and carbon dioxide elimination as soon as the lungs are ventilated. Neither the tying of the umbilical cord nor the first breath of the infant precipitate any sudden radical change in the course of blood through the heart. During the first weeks after birth, under the stimulus of the functional activity of the lungs, the pulmonary circulation rapidly gains in power and volume. The progressive diminution in the bore of the ductus arteriosus is concomitant and indicative of this increase.

As the pulmonary circulation becomes greater there is less compensatory flow through the foramen ovale from the right to the left atrium. This reduction in flow is evidenced anatomically by a gradual reduction in the fulness of the valvula foraminis ovalis, and the consequent diminution of the functional orifice to a progressively narrower slit between the valvula and the septum. The morphological change which most clearly marks the termination of this primary period of readjustment of the circulation to extra-uterine life is not, however, at the foramen ovale; it is the final obliteration of the diminishing lumen of the ductus arteriosus. This occurs on the average about eight weeks after birth. When blood can no longer be short-circuited by way of the ductus arteriosus it must of necessity go through the lungs. As soon as all the blood which enters the right side of the heart traverses the pulmonary route and is returned to the left atrium, a balance

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Table of Incidence of Quadruplets (Hermstein and Pfalz)

Author.	Total births.	Incidence of quadruplets.
		One in
Veit—Mekel	13,000,000	371,176
Neefe and Sickel	560,000	560,000
Wappäus	19,500,000	333,870
Guzzoni	50,000,000	757,000
Häuser	1,971,759	657,253
Häfeli	4,406,289	550,786
France	....	2,074,306
Württemberg	....	110,000
Average	....	676,799

pregnancy is more common in cold climates, the age of greatest frequency being from twenty-five to twenty-nine years. Das has reported 3 cases of twins in very young primiparae between the ages of eleven years, ten months, and fourteen years, nine months.

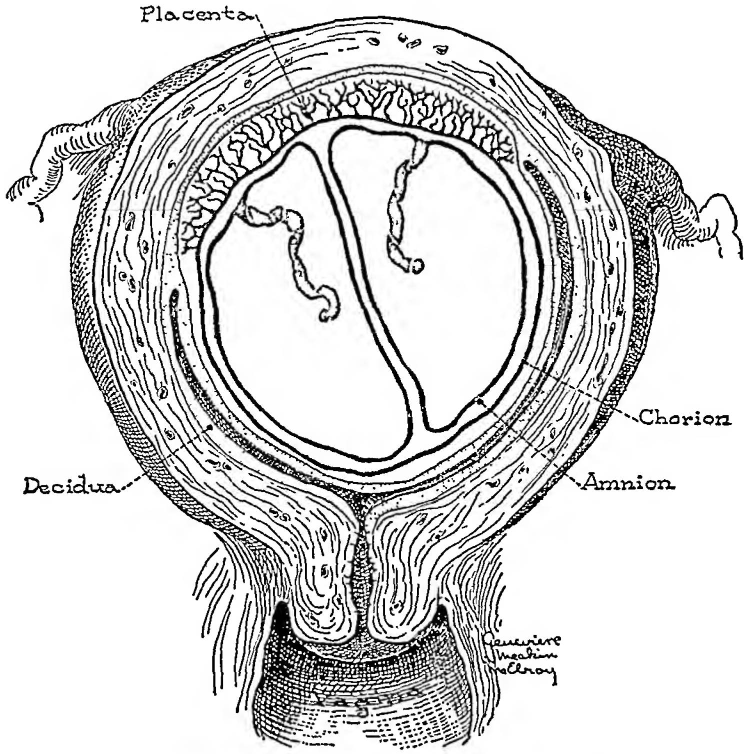

Fig. 480.—Homologous or single ovum twins.

Etiology.—Developmentally, two types of twins are commonly recognized. Homologous or identical twins develop from a single ovum and are the only true twins. Binovular or fraternal twins are not twins at all, but are instances of simultaneous development of two ova due to an hereditary twinning tendency. Such "false" twins are akin to members of a litter in animals. Single ovum twinning is not directly inheritable, but results from environmental factors influencing the course and rate of development of the egg. Developmental inhibition or arrest of the fertilized ovum, according to Stockard, is responsible for all abnormal development including that of identical twinning. Any factor which inhibits development at the onset

arise by fusion of previously separate ova, the limiting membrane disappearing between them; also that polyovular follicles are the remains of Pflüger's tubes that have failed to separate; binuclear ova cannot seriously be considered, he concludes, in connection with one-egg twinning in uniparous species.

Each ovum develops its own placenta which may remain separate or may fuse depending upon their proximity in the uterus. Even when fused,

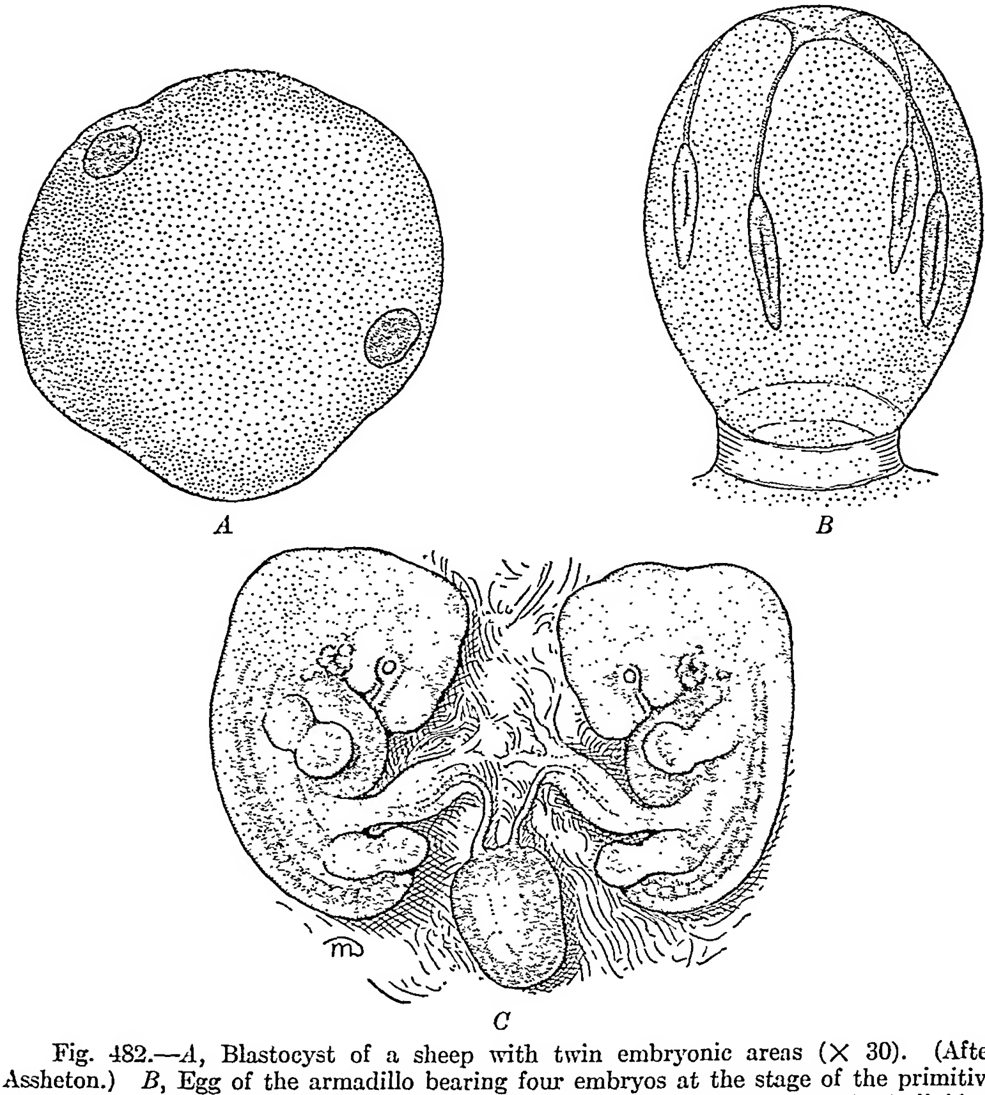

Fig. 482.—*A*, Blastocyst of a sheep with twin embryonic areas (× 30). (After Assheton.) *B*, Egg of the armadillo bearing four embryos at the stage of the primitive streak (× 4.5). (After Patterson.) *C*, Twin human embryos of 12 mm. with individual yolk stalks attached to a common yolk sac (× 3.5). (From Arey, "Developmental Anatomy.")

each ovum usually retains its own amnion and chorion, and the four layers may readily be identified in the septum between the two sacs. The two placentae may be separated in the line of fusion without injury to any of the blood vessels as there is no intercommunication of the two circulations. The term "monochorial" need not always denote a single ovum origin, for as Arey has shown in twin tubal pregnancy, two fetuses may occupy a single

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Fig. 484.—Twins diagnosed roentgenographically. Double breech. (Michael Reese Hospital, Chicago.)

Fig. 485.—Radiograph of twins. Cephalic and breech. (Michael Reese Hospital, Chicago.)

Interval.	Cases.
None	364
15 minutes	386
30 minutes	301
30–45 minutes	52
45–60 minutes	156
1–22 hours	228

that no indication arises for haste or interference. After the delivery of the first child the cord should be doubly ligated and cut between, and the uterus should then be palpated to determine the presentation of the second twin. If the diagnosis is in doubt, a vaginal examination should be made. If the head or breech presents, expectancy again may be practiced for at least twenty minutes before rupturing the membranes. But if the second twin is found upon examination to present transversely, a podalic version under general anesthesia should immediately be done. If the second child is not born within an hour after rupture of the membranes, extraction with forceps or delivery by Kristellar's method may be indicated. If delay is

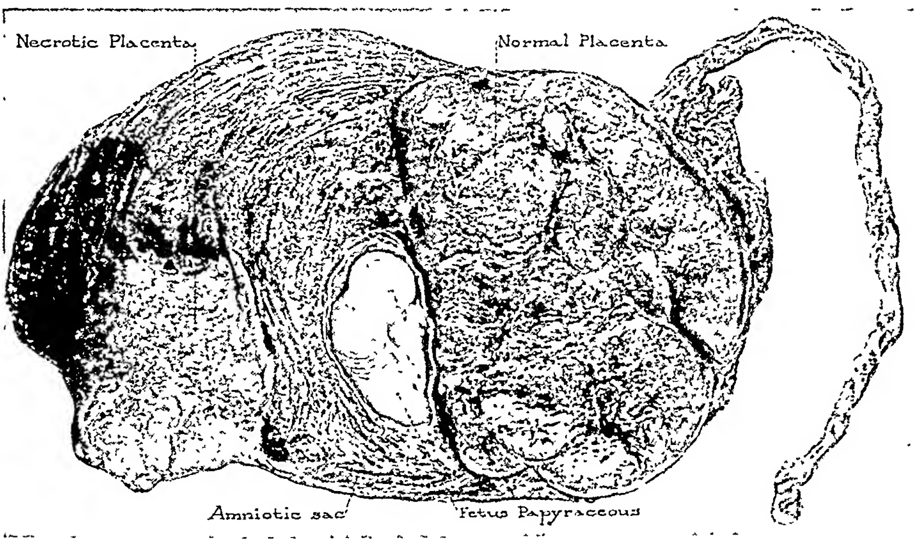

Fig. 489.—Fetus papyraceous. (Michael Reese Hospital, Chicago.)

due to ineffective labor pains, very small doses, 1 or 2 minims only, of pituitary extract may be used to accomplish the delivery of the second twin. After the birth of the second, however, half an ampule (7.5 mm.) of pituitary extract should be given, and following the expulsion of the placentae and membranes an additional full ampule (15 mm.) is administered to prevent postpartum hemorrhage. Ergot is also administered (1 drachm by mouth, or 15 mm. intramuscularly) but only after completion of the third stage of labor, and its use may be continued for the first few days of the puerperium in 15 mm. doses of the fluidextract, by mouth t.i.d.

Complications.—During pregnancy the most frequent complications encountered are hydramnios, placenta praevia, eclampsia, and prematurity. During labor, delayed labor, malpresentations, collision or interlocking, and delivery of fetal malformations may be met. Placental anomalies are also observed.

occupancy of separate amniotic sacs. The births are likely to be consecutive and uncomplicated. When, however, there is delay in the progress of the birth of the first child, an examination is indicated to determine the cause of the delay.

Dystocia may be found to be due to the engagement of both heads in the pelvis. If so they will deliver simultaneously only in case the fetuses are very small. When both heads are discovered in the pelvis, the patient should be placed in the Trendelenburg position and under general anesthesia

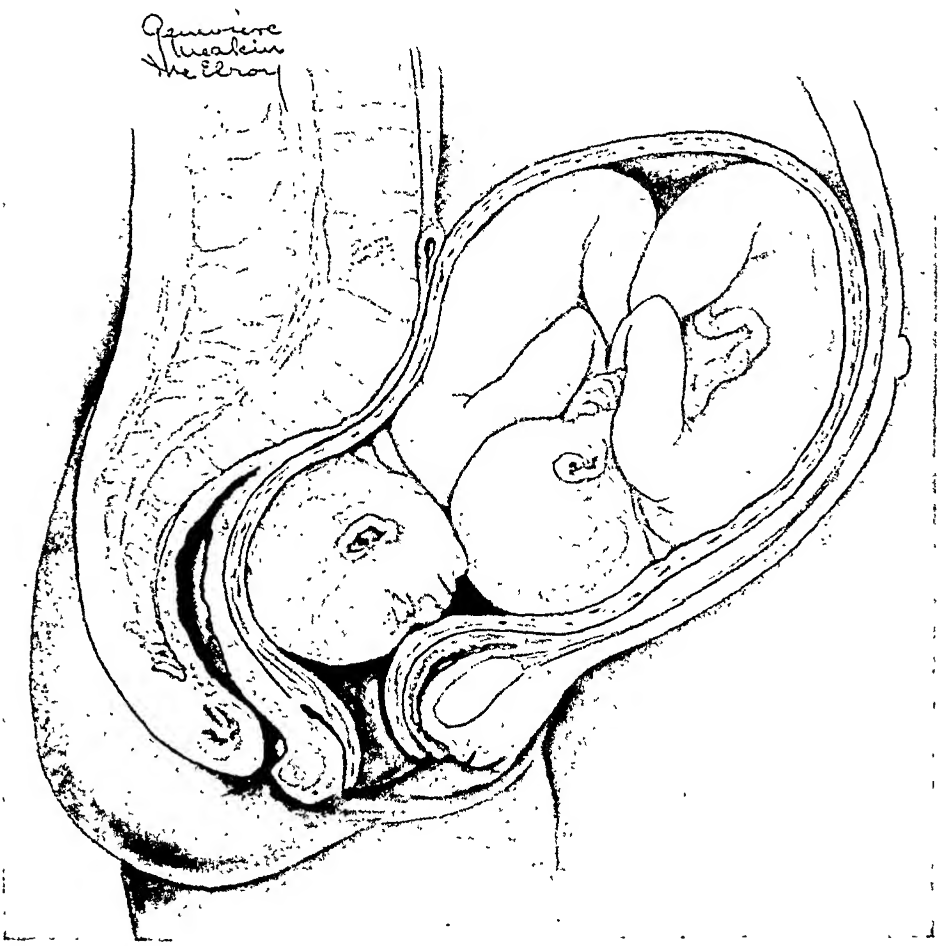

Fig. 491.—Interlocked twins. Both cephalic. The head of the second twin is impacted with the chest of the first child.

the whole hand is introduced into the vagina and one head is pushed out of the pelvis. The other fetus is then extracted with forceps. The second may be allowed to deliver spontaneously, or be likewise extracted. If it is found that the first fetus cannot pass the head of the second, craniotomy on the first child, which has already been subjected to the greater trauma, may be indicated. The second child can then be delivered. Occasionally, when both heads have been dislodged, podalic version may be done to accomplish the birth of the first child, and the second delivered spontaneously or with forceps.

is followed only after a careful study of the predicament, and after consultation. Radiography should be employed to clarify the exact relationship and the size of the twins. It may reveal the presence of one normal and one

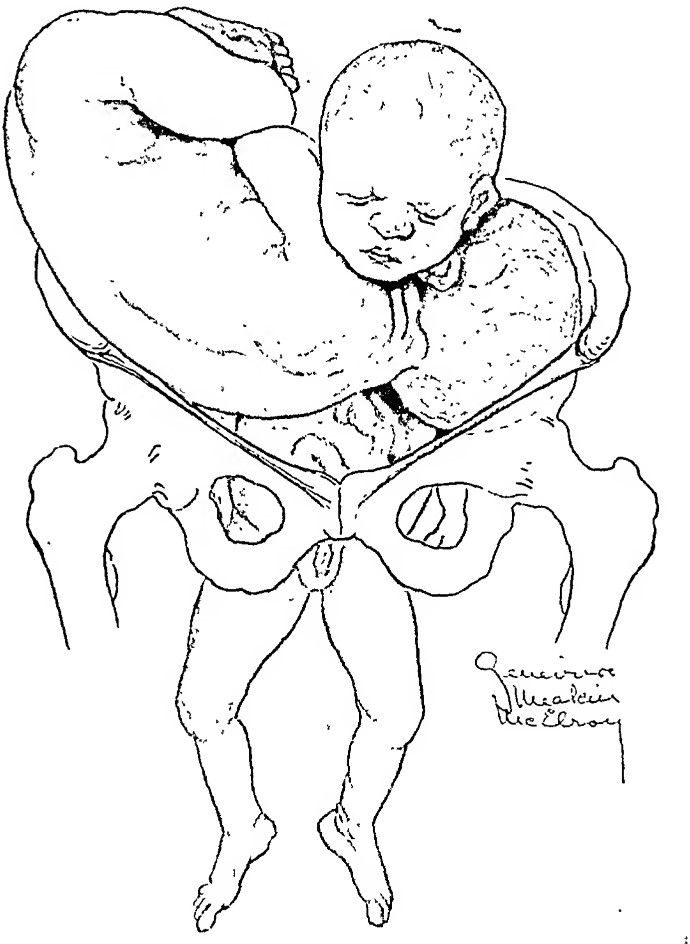

Fig. 493.—Interlocked twins. Breech and transverse. The chin of the first child is caught on the neck of the second, transverse twin.

malformed fetus, in which case the normal child should at all events be saved. Joined twins may present diagnostic difficulties which even the x-ray may not reveal, and treatment may tax the ingenuity of the obstetrician.

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SECTION VII

PATHOLOGY OF PREGNANCY

CHAPTER XXIX

MATERNAL ILLNESSES COMPLICATING PREGNANCY

By William S. Middleton, M. D.
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Contents:

particularly interesting in that no miscarriages had occurred; one premature delivery and one stillbirth were reported; early death from hypertrophic pyloric stenosis accounted for a third baby. Maternal improvement or complete relief was the universal return. No maternal deaths occurred during the pregnancy, labor or puerperium of this series. One mother ended her life by suicide and the literature indicates a psychotic tendency in the puerperium of women suffering from these coincident conditions.

Falls[14] voiced a much more conservative attitude relative to surgery in the treatment of thyrotoxicosis complicating pregnancy. Bed rest and iodine were advised as long as the progress is satisfactory. Indeed he urged no surgical interference until medicine fails or, where possible, postponement of surgery until the thirty-fifth week, when premature delivery or thyroidectomy without risk to the baby may be considered. He admitted that the maternal mortality in early thyroidectomy is only 1 per cent but still favored conservatism. Falls advised lightening the burden of labor by shortening the second stage; or if the very toxic subject presents herself too late for proper iodine preparation, cesarean section must be considered.

Surgery in proper hands increases the risk to these patients very little if at all. Where medical management over a reasonable period of time bids fair to prove successful, thyroidectomy may be postponed until after delivery in the hope that the more normal conditions postpartum may obviate its necessity; but where the initial state of thyroid intoxication has been more serious, the temporary respite gained through iodine must not be lost—surgery is indicated as soon as a plateau of improvement is achieved. Obviously many of the old indications for the interruption of pregnancy in the presence of thyrotoxicosis have been swept away by the progress in the management of the latter condition. Hinton[15] cited two indications for inducing abortion in these patients, namely myocardial degeneration from a toxic adenoma and a fulminating course in Graves' disease. The experience at Rochester[13] would exclude even these exceptions. Pregnancy should be interdicted for two years after a thyroidectomy even though the operation be successful in every detail, according to Williamson.[16] Should conception occur in spite of advice, unusual precautions should be taken in affording rest, sedative medication, iodine and thyroid substance as the needs require. Williamson gave a very pessimistic picture of the prospect for normal offspring after thyroidectomy, a viewpoint which is not generally held.

Daly and Strouse[17] called attention to an interesting borderline condition in pregnancy which doubtless represents a mild grade of thyrotoxicosis. Nervousness, irritability, emotionalism, palpitation, easy fatigability, tremor, enlargement of the thyroid gland, elevated blood pressure, tachycardia and occasionally eye signs may be noted. As a rule these adverse manifestations appear from the fourth to the sixth months. Too frequently they are dismissed casually by the physician as simply dependent upon pregnancy. It is important to note that this syndrome does not commonly respond to the bromides, but the compound solution of iodine (Lugol's) in doses of 3 to 5 drops three times a day for a week, repeated if necessary after one or two weeks' rest, will give complete relief. Two courses of Lugol's solution usually suffice, but occasional recurrences are noted in lactation. In a large series of cases of this type Davis[18] confirmed the report of salubrious results from iodine administration and furthermore urged its prophylactic use in

well as the concentration of diffusible calcium is higher in the umbilical vein of the newborn than in the venous blood of the mother.

Tetany.—The occurrence of this condition as a complication of pregnancy was recognized in 1854 by Trousseau under the designation, "contracture des nourrices." Before the fundamental observations of MacCallum and Voegtlin,[1] Frommer[6] and Adler and Thaler[7] had carefully reviewed the field and demonstrated that experimental removal of appropriate portions of the parathyroid glands in animals was unattended by adverse symptoms, but that pregnancy occurring in these animals would precipitate the classical spasms of tetany. Hence the persistence of enough parathyroid substance to prevent tetany in the nongravid animals was inadequate for the needs of the same animals when pregnancy supervened, and tetany occurred as the result of partial functional insufficiency of the parathyroid glands. Meinert[8] gave one of the best clinical descriptions of the condition and pointed out in a case under his care the tendency for recurrence of the symptoms in subsequent pregnancies. One of the most striking examples of this tendency was reported by Thomas.[9] In his patient, a multipara of thirty-three years, the manifestations of tetany had recurred in six successive pregnancies. The circumstances of such attacks were noteworthy. For the first semester of each pregnancy the patient was apparently entirely well. Then there occurred daily attacks of tetany until three or four weeks before confinement. Only once was there any sign of spasm during labor. In all instances except the last, a severe seizure occurred on the ninth day post-partum. Again, with a single exception (second child) no attacks occurred during lactation. With the return of menstruation the tetany recurred, especially at the time of the menses during cold weather. There was virtual freedom from symptoms in the summertime. In most details this case coincides with the analysis of 52 cases collected from the literature by Fränkl-Hochwart,[10] who likewise remarked the occasional tendency of the newborn child to have tetany either shortly after birth or more remotely.

The condition of faulty calcium metabolism termed "latent tetany" doubtless occurs much more commonly in pregnancy than is generally appreciated. Hartley[11, 12] listed among the symptoms constituting this, as yet ill-defined tetanoid syndrome, cramplike pains in the legs and thighs, irritability unusual to the subject, insomnia, paresthesias in the extremities and edema which is neither cardiac nor nephritic in origin. In his experience, certain menstrual cramps portended more serious manifestations during pregnancy. Rather minor increases in blood calcium under proper therapy were attended by unequivocal clinical improvement in this group of cases. Sincock,[13] in a careful analysis, checked by studies of the electrical responses to the galvanic current as well as by blood calcium determinations, confirmed the work of Hartley. Cathodal opening contraction at a level below 5 ma. should suggest calcium deficiency and, by common standards, 8 mg. of blood calcium constitutes a hypocalcemia.

Both Hartley and Sincock subscribe to the calcium privation theory, and the reported responses in the cases of latent tetany to the exhibition of this element in excess lend force to this position. Hence, a diet rich in milk, vegetables and fruits will afford an adequate source of calcium; and viosterol and cod liver oil will supply vitamin D, which plays an important rôle in the metabolism of calcium. Fresh air and sunlight, with artificial ultraviolet

months of a given pregnancy and then recurrences of increasing severity and longer duration are noted in succeeding gestations. Authorities are agreed that the hygienic conditions attendant upon pregnancy are important factors in the pathogenesis of this obscure condition, which is linked so intimately with hyperparathyroidism in some of its salient features. Scott[15] listed three outstanding predisposing factors from her Indian experience, namely, child marriage, prolonged lactation and purdah. One of the most startling revelations of her study was the protracted period of lactation, which averaged 2.37 years among her osteomalacic subjects. Sixty-nine of 82 individuals in this group developed evidences of the disease during pregnancy or the period of lactation. McCrudden[23] named the following circumstances as contributory: damp buildings, lack of clothing, poor food, repeated pregnancies, prolonged lactation, hard work and lack of care.

The treatment of osteomalacia is primarily hygienic; but since it is a manifestation of calcium deficiency, this element must be supplied in excess. The absorption of calcium is enhanced when given on an empty stomach. The average dose of 1 to 2 Gm. of calcium lactate may be given once or twice each morning before breakfast and spaced as far between meals as possible. The intravenous route is ordinarily not necessary nor is it advisable. Cod liver oil and viosterol have an assured place in all types of calcium deficiency. Heliotherapy and ultraviolet light may also prove helpful. Therapeutic abortion is not indicated; but McCrudden[23] advised roentgen-ray sterilization in view of the hazard of repeated pregnancies. Jägerroos's experiments[26] may explain the escape of the offspring in the majority of instances. He found in dogs that even on a negative maternal balance of phosphorus, nitrogen and salt, the puppies developed at the expense of the bitch.

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(*A*) Apparently innocuous:

1. Alimentary glycosuria (temporary but not sustained hyperglycemia).
2. Glycosuria of pregnancy (maintained hyperglycemia disappearing early in the puerperium).
3. Renal glycosuria (low renal threshold without hyperglycemia).
4. Lactosuria (more correctly a puerperal concomitant of lactation).

(*B*) Potentially serious:

1. Certain cases of the glycosuria of pregnancy (showing a failure of postpartum readjustment).
2. Diabetes mellitus (low sugar tolerance; glycosuria with hyperglycemia).

The above analysis, modified from Lambie,[5] needs no further elucidation other than to point out the necessity for blood sugar determinations and sugar tolerance studies in the presence of sugar in the urine. The simple expedient of a fermentation test will establish the nature of the sugar. Lactose is not fermentable.

The usual tendency for pregnant women to show a glycosuria has been explained by Benthin[6] on the basis of a functional insufficiency of the liver, with impaired glycogenesis. Williams[1] subscribed to a pituitary responsibility. The recognized pituitary hyperplasia during pregnancy with postpartum involution and coincident disappearance of the glycosuria was cited in support of this view. There is a peculiar tendency for renal glycosuria to recur in successive pregnancies and Williams and Wills[2] believe that the renal threshold is probably lowered in all normal pregnant women. However, only 4 in their series of 21 glycosurias in pregnancy failed to show a hyperglycemia.

Diabetes Mellitus.—Diabetes mellitus may make its first appearance in the course of pregnancy; and John[7] felt that the explanation for this occurrence is probably to be found in a hydropic degeneration of the beta cells of the islands of Langerhans, as described by Copp and Barclay[8] in dogs. This process was a reversible one under insulin therapy, but recovery was quite slow. The development of pancreatic necrosis in the course of pregnancy which Ellerbrock[9] has reported must be quite rare.

Duncan[10] wrote one of the earliest dissertations upon this subject and in addition to pointing out its gravity remarked the infrequence of its occurrence. Sterility was common in the pre-insulin period, as was impotence in the diabetic male. Fitz and Murphy[11] early reported conception after the use of insulin in a diabetic whose menses had been suppressed for two years. Joslin and his co-workers[12] have noted the institution of menstruation in 4 girls one to two months after the use of insulin. The duration of diabetes in the group ranged from two months to six and a half years. Without insulin no girl in this series developed the menstrual cycle after the onset of diabetes. An added group of 6 patients experienced marked irregularity or cessation of menstruation soon after the onset of diabetes when insulin was not administered. Parsons, Randall and Wilder[13] reported 11 instances of pregnancy among 285 diabetics of childbearing age. They surmise that amenorrhea and sterility may depend upon failure of ovulation. In their series of 11 pregnancies there was 1 mild diabetic who had had the disease for seventeen years and in this period had given birth to 3 normal children. The pregnancies of the remaining 10 terminated less successfully in that 2 stillbirths and 4 miscarriages occurred. In their judgment it is doubtful

The introduction of insulin into the therapy of diabetes has entirely revolutionized its management and prognosis. However, even prior to its discovery the keynote of conservatism had been sounded by such leaders as Offergeld,[24] who pointed out that sacrifice of the child by the interruption of pregnancy by no means insures the safety or well-being of the mother. The relationship of pregnancy to the pancreatic disturbance is not constant. At times pregnancy merely complicates or aggravates a preexistent fault in sugar metabolism. Again, diabetes mellitus may, as previously discussed, first make its appearance during the course of pregnancy. The supplemental contribution of fetal insulin may improve the maternal utilization of carbohydrates late in pregnancy; but this is not a constant reaction, nor can it be depended upon. Holzbach[25] remarked the sharp ascent of the maternal blood sugar upon the death of a fetus which had been contributing to the improved combustion of carbohydrates by the mother. He emphasized the probability of the transition from a compensated to a decompensated diabetes under such conditions. Furthermore, according to Kraul,[26] it not infrequently happens that pregnancy complicating diabetes leads to the necessity for a complete revision of diet and insulin dosage with an apparent loss of efficacy in the latter. In other diabetics there may occur a sudden crisis in labor or early in the puerperium. If to these variables be added a knowledge of the reduction of plasma bicarbonate in the latter half of pregnancy, which is compensated for by a reduced CO_2 tension of the blood to maintain a relatively stable acid-base equilibrium,[27] the danger of serious consequences dependent upon the disturbed chemistry of the body will be appreciated.

In general pregnancy should be interdicted in all diabetic women with a familial background of this condition because of the serious prospect of diabetic progeny. Even were this a more remote possibility than experience and study indicate, a strictly eugenic viewpoint would forbid the marriage of, or conception in, diabetic couples. With the exception of such familial diabetics, this fundamental fault in sugar metabolism is per se no longer a contraindication to pregnancy. Insulin has simplified the general problem; but a number of specific questions will arise in the conduct of practically every individual diabetic during pregnancy. For example, the diet will remain the usual thoroughly controlled unit of management; but Stander and Cadden[28] have pointed out the tendency to an increase in the ketone bodies even in normal pregnancies. Hence they favored a diet low in fats and high in carbohydrates, especially if there were any evidences of ketosis in the toxemias of pregnancy. The application of this information to diabetes in pregnancy is inferred rather than established, since there are no corresponding data upon pregnant diabetics; but it would seem justifiable to conclude that the ketogenic-antiketogenic ratio would have to be more rigidly enforced in the presence of pregnancy than in the nonpregnant diabetic. Accordingly it would not appear sound practice to exceed the 1.5 : 1 ratio of available fatty acid to glucose prescribed in usual diabetic diets. Insulin should be adjusted to the need of the individual subject. Since this need will change with the altered carbohydrate metabolism of the mother and the fetus, daily observation should be kept of the urine by the instructed patient and weekly urinalyses and blood sugar determinations should be made by the attending physician. The readjustment of the insulin dosage may then

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Suprarenal Glands

A physiologic hypertrophy of the suprarenal glands has been observed in menstruation and in pregnancy. The cortical cells apparently are more affected than are those of the medulla.

Addison's Disease.—Suprarenal insufficiency of any origin is not a common condition. Hence it is not surprising that Addison's disease should be very unusual in pregnancy. In 1922 Fitz-Patrick[1] gathered from the literature 12 cases of this condition complicating pregnancy, labor and the puerperium. In this group were included 2 cases occurring during the puerperium. In the comprehensive monograph of Rowntree and Snell[2] two further examples of the occurrence of pregnancy in the course of the disease are recorded. In this relation, an interesting experience was encountered on the Medical Service of the Wisconsin General Hospital in a multipara who had last menstruated four years previously, after the birth of her first child. Two subsequent pregnancies had occurred. A month after the beginning of the third pregnancy there first appeared a deep pigmentation over the entire body, which progressed steadily and had, as a distinctive additional feature, great numbers of small dark "moles" over the face and neck. This pregnancy was concluded at term by the birth of the third normal child; the characteristic asthenia of Addison's disease did not supervene for several months postpartum. The gastro-intestinal crises were delayed until ten months after delivery, when a syncopal attack with delirium initiated the decline which terminated in death a month later.

The diagnosis of this complication offers certain difficulties in the face of the gastric unrest and the pigmentation of pregnancy. In Addison's disease the nausea and vomiting may be misleading by its appearance in the morning before arising. More characteristic are the crises of epigastric distress, vomiting and, occasionally, profuse diarrhea in Addison's disease. The asthenia is profound and weight loss is virtually the most conspicuous sign

Pituitary Body

Diabetes Insipidus.—Vickers[1] recounted a single instance of pregnancy occurring in a subject with diabetes insipidus. Acute urinary retention complicated the picture and although pituitrin had been intentionally withheld, the patient miscarried at three months. Vickers believed that benzyl benzoate in 0.3-Gm. doses twice a day afforded some relief from the symptoms of retention.

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DISEASES OF THE HEMATOPOIETIC SYSTEM

Although the hematopoietic apparatus of the fetus is distinct from that of the mother, the latter's blood must carry oxygen and nutrition for both. In order to supply the maternal and fetal needs an unusual burden is placed upon the blood-forming mechanism of the mother during pregnancy. It is not surprising, then, that rather pronounced changes should be noted in the cellular elements of the peripheral blood at this time. Bland, Goldstein and First,[1] among others, have established the definite tendency to a reduction of the hemoglobin and the erythocytes, which is progressive with the advance of pregnancy. The direct relationship of pregnancy to the anemia was established by a prompt improvement in a majority (72.6 per cent) within ten days after delivery and a marked gain in both hemoglobin and erythrocytes in over 90 per cent of cases after several months. Kerwin and Collins[2] likewise demonstrated an increased rate of hemoglobin and erythrocyte loss late in pregnancy and added an interesting observation on the greater tendency for anemia to develop in old multiparae than in primiparae or younger multiparae. One of the most significant observations in this direction was made by Muller,[3] who proved that Weber's drawing ink, injected intravenously into normal rabbits, induced great showers of nucleated erythrocytes with subsequent anemia, whereas in pregnant rabbits no such primary shower occurred and just before delivery there was no normoblastosis after such injections. Apparently the experimental hematopoietic response is greatly inhibited by pregnancy.

The leukocytes are little changed early but rise steadily during the course of pregnancy, to reach a slightly elevated plane antepartum. Rowe[4] found that the differential distribution remains about normal. Particular interest attaches to the blood platelets in pregnancy. Bland, First and Goldstein[5] found 77 per cent of 230 pregnant women to have normal counts and 18.2 per cent above normal. While the values were rather inconsequential in view of the admitted technical difficulties in enumerating platelets the tendency to appreciable increases postpartum was conspicuous in a majority of the subjects studied.

The sedimentation rate of the erythrocytes has attracted much attention in the field of gynecology and obstetrics. In a comprehensive review Fåhraeus[6] found the sinking velocity, as he terms it, to be increased beyond normal in pregnancy. The following figures, taken from his data on 100 pregnant women, are significant when a sinking velocity of thirty minutes is considered rapid.

Pituitary Body

Diabetes Insipidus.—Vickers[1] recounted a single instance of pregnancy occurring in a subject with diabetes insipidus. Acute urinary retention complicated the picture and although pituitrin had been intentionally withheld, the patient miscarried at three months. Vickers believed that benzyl benzoate in 0.3-Gm. doses twice a day afforded some relief from the symptoms of retention.

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DISEASES OF THE HEMATOPOIETIC SYSTEM

Although the hematopoietic apparatus of the fetus is distinct from that of the mother, the latter's blood must carry oxygen and nutrition for both. In order to supply the maternal and fetal needs an unusual burden is placed upon the blood-forming mechanism of the mother during pregnancy. It is not surprising, then, that rather pronounced changes should be noted in the cellular elements of the peripheral blood at this time. Bland, Goldstein and First,[1] among others, have established the definite tendency to a reduction of the hemoglobin and the erythocytes, which is progressive with the advance of pregnancy. The direct relationship of pregnancy to the anemia was established by a prompt improvement in a majority (72.6 per cent) within ten days after delivery and a marked gain in both hemoglobin and erythrocytes in over 90 per cent of cases after several months. Kerwin and Collins[2] likewise demonstrated an increased rate of hemoglobin and erythrocyte loss late in pregnancy and added an interesting observation on the greater tendency for anemia to develop in old multiparae than in primiparae or younger multiparae. One of the most significant observations in this direction was made by Muller,[3] who proved that Weber's drawing ink, injected intravenously into normal rabbits, induced great showers of nucleated erythrocytes with subsequent anemia, whereas in pregnant rabbits no such primary shower occurred and just before delivery there was no normoblastosis after such injections. Apparently the experimental hematopoietic response is greatly inhibited by pregnancy.

The leukocytes are little changed early but rise steadily during the course of pregnancy, to reach a slightly elevated plane antepartum. Rowe[4] found that the differential distribution remains about normal. Particular interest attaches to the blood platelets in pregnancy. Bland, First and Goldstein[5] found 77 per cent of 230 pregnant women to have normal counts and 18.2 per cent above normal. While the values were rather inconsequential in view of the admitted technical difficulties in enumerating platelets the tendency to appreciable increases postpartum was conspicuous in a majority of the subjects studied.

The sedimentation rate of the erythrocytes has attracted much attention in the field of gynecology and obstetrics. In a comprehensive review Fåhraeus[6] found the sinking velocity, as he terms it, to be increased beyond normal in pregnancy. The following figures, taken from his data on 100 pregnant women, are significant when a sinking velocity of thirty minutes is considered rapid.

portionately to the erythrocyte loss. Normoblasts are found in the circulating blood and there is a slight leukocytosis.

In the postpartum group III of Osler[10] are included those cases which tend to simulate pernicious anemia so closely. Channing[9] quoted the observations of Stevenson concerning a patient dying eighteen days postpartum thus: "A person ordinarily in good health, having no perceptible disease except a moderate bronchitis, suddenly becomes pale, the surface of the body being waxy and bloodless; she is faint and fatigued; capable of great bodily efforts, which, however, produce palpitation and distress; she has pain in the head, impatience of light, throbbing at the temples, and sometimes an universal throbbing, slight confusion in the mind, and a sense of total and extreme prostration." Pepper[13] drew a clear clinical picture of the entity. It probably occurs early in pregnancy but is not commonly recognized until the seventh month when paraesthesias, dyspnea and general anasarca may supervene. Retinal hemorrhages may appear.[14] The spleen is enlarged and an afternoon rise of temperature may be present. Contrasting with pernicious anemia there is not uncommonly a slight leukocytosis with an absolute neutrophilic increase. The absence of spinal cord changes and of macrocytosis are helpful points in excluding pernicious anemia. Sore tongue with atrophy of the papillae is an important finding in these patients.[15] There is no constancy in the status of the gastric acidity. As a rule, the free hydrochloric acid is either reduced or entirely absent from the gastric contents.[16, 17]

Many theories have been proposed in explanation of this grave form of anemia; but their number justifies the doubt which still exists in the judgment of the majority. Schneider[18] felt that it represented a hemolytic anemia from a specific toxin. Rowland[19] subscribed to the theory of a syncytial hemolysin arising from the ectodermal cells of the chorion. Alder's[11] viewpoint, of a primary bone marrow injury upon which the engrafted burden of the pregnancy proves too heavy for the continuance of normal hematopoiesis, would seem to offer the soundest explanation. Early writers on the subject of pernicious anemia, as Müller,[20] made no effort to distinguish between Addisonian anemia and the anemia of pregnancy and the puerperium; but the perpetuation of the term "pernicious" in this relation would scarcely seem justifiable in the light of present knowledge. Esch's[14] observation of the megaloblastic type of regeneration in this form of anemia was the strongest ground for its continuance in the past; but it is now appreciated that the anemia of sprue and dibothriocephalus latus infestation, among other conditions, may lead to a megaloblastic regeneration just as does pernicious anemia. The clinical course alone should long since have eliminated this designation. Osler[10] wrote, "When recovery takes place it is permanent, and the woman may escape in subsequent pregnancies." In general this statement is true; but there are cases of recurrence in successive pregnancies on record. Unless recognized early and treated vigorously, there is a high fetal and maternal mortality. Stillbirths are frequent in the presence of this type of anemia; and, as noted by Channing,[9] labor may be remarkably short and painless and the bleeding conspicuously slight at delivery.

The treatment of the anemias secondary to hemorrhage or sepsis will depend upon the control of the underlying cause supported by diet, iron, ultraviolet light or heliotherapy, transfusions and such other measures as

questioned the diagnosis of one of the series reported. The case of Bindung, Eubert and Wheldon did not appear substantiated as one of splenic anemia. In the case reported by Hesseltine the diagnosis was confirmed by histologic section after the splenectomy which was performed in the third month of pregnancy. The liver was hobnailed and the spleen weighed 600 Gm. In spite of the serious liver damage revealed at the time of this operation the mother carried the child to term without evincing any sign of toxemia. The child was delivered spontaneously and was normal in all respects. The mother showed marked ascites shortly after delivery; but subsequent to the removal of 7 liters of straw-colored fluid there was no reaccumulation. One of Larrabee's atypical anemias with a large spleen showing increased fragility of corpuscles might well have been a splenic anemia, since after proper preparation by repeated transfusions a splenectomy effected complete relief.

Aplastic Anemia.—Larrabee reported a single instance of this rare condition complicating pregnancy. The great reduction in the platelets and the absence of evidences of erythropoiesis and of hemolysis are characteristic points. Usually the leukocytes are reduced in number. Exposure to radiant energy, benzol and other similarly operative substances in industry have been cited as etiologic factors. In spite of treatment the course is progressively downward to a fatal termination.

Polycythemia.—Parlicki reported an isolated instance of the coexistence of this condition with pregnancy. The polycythemia was of seven years' duration. Singularly with pregnancy the erythrocytes fell from 11.5 to 7 millions. Several years later the red cell count had again mounted to 9.5 millions. DeLee cited 2 cases of polycythemia in his personal experience in which the influence of pregnancy was deleterious rather than beneficial. In both instances the spleen reached to the brim of the pelvis and intense cyanosis with polycythemia completed the picture. In the first instance two children had been born before the appearance of the disease; but sterility succeeded its advent. In the second, two macerated stillborn fetuses appeared before a normal child was born, apparently as the result of iron, arsenic and mercury therapy. Then sterility concluded the reproductive history.

Leukemia.—Much of the early literature on the unusual complication of leukemia in pregnancy is confused by a lack of clinical definition. For example in the frequently quoted case reported by Cameron a diagnosis of leukemia was derived from the marked anemia, leukocytosis and splenic enlargement. Three pregnancies occurred subsequent to the demonstrable enlargement of the spleen, and during the course of each the spleen was even more enlarged. Furthermore, six members of the family as well as the patient had shown jaundice from time to time. A diagnosis of familial hemolytic icterus would seem justified. In general, none of the earlier cases fulfill all of the diagnostic requisites of the present day. In many instances the ratio of leukocytes to erythrocytes alone constituted the final basis for decision as to the leukemic nature of the subject.

Acute Leukemia.—In 1921 Hoerner reviewed the literature relating to the occurrence of acute leukemia in pregnancy. Twelve cases were found by him and to this number he added 2. Delivery was usually easy. The myelophthisic factor as pointed out by Allan may lead to grave anemia through the crowding out of erythroblastic tissue in the bone marrow by

normal clotting time and noncontractility of the clot are the same in pregnant as in normal women. Especial significance attaches to this complication of pregnancy in the marked tendency for metrorrhagia and premature delivery and the less common occurrence of infection. Rushmore[18] in an excellent review of the subject noted that it was more common among multiparae late in pregnancy. Of 44 adequately reported cases 26 terminated fatally for the mother; and of 42 instances giving the outcome for the child 27 succumbed. Mosher[49] gave the fetal mortality as 50 per cent and stated that practically all mothers who go to term die upon delivery, or soon after, from hemorrhage. Liebling[50] and Morgan,[51] among others, noted that a small proportion of the offspring of purpuric mothers have the same tendency.

So important is this matter that Lehfeldt[52] and Ohnesorge[53] have urged the necessity for a careful determination of the platelet count, whenever there is a hemorrhagic tendency. A transitory type of thrombopenia was described by the latter. Transfusions are indicated whenever the platelets are sharply reduced; and close observation of these cellular elements will doubtless result in a wider application of prophylactic transfusions for their deficiency. Because of the particular danger of fatal hemorrhage at the time of delivery preparations should be made to meet this emergency by transfusions. Therapeutic abortion is dangerous in the presence of purpura. Splenectomy has promised a great deal in the ultimate control of this condition; but the literature offers little encouragement for its application.[54] From the present viewpoint it is nevertheless the management of choice. Roentgen-ray therapy to the splenic area has not fulfilled the claims of its proponents.

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DISEASES OF THE RESPIRATORY SYSTEM

Influenza.—The gravity of influenza as a complication of pregnancy has been appreciated for many years. The anoxemia and profound toxemia attendant upon its more serious forms, together with its singular hemorrhagic tendency, undoubtedly explain the danger in great part. Contrary to the common experience, Bar and Boullé[1] in a study of 50 cases reported no unusual tendency to abort and a mortality of only 8 per cent. A more critical inclusion of only such patients as showed a leukopenia, marked constitutional symptoms and profound asthenia would doubtless correct such figures.

An unusual opportunity to study this complication was afforded by the pandemics beginning in 1918. As a result of this experience a number of important contributions to the subject appeared in the American literature within a comparatively short time.[2, 3, 4, 5, 6, 7] The report of Harris[3] was the most comprehensive and included the largest series. Thirteen hundred and fifty cases occurring in pregnant women were analyzed, among whom pneumonia complicated the influenza in approximately one half (678 instances). The mortality for the entire group was 27 per cent, as compared with a mortality of 54 per cent among those complicated by pneumonia. Of exceeding prognostic importance was Harris' observation that the mortality advanced in the last three months of pregnancy, when pneumonia complicated the picture, reaching the high level of 61 per cent in the ninth month.

Titus and Jamison[5] attributed the high abortion rate (80.9 per cent in their series) to deoxygenation of the blood, carbon dioxide accumulation and toxemia in the fetus. They believed that in the latter months the first two factors are most probably operative in the initiation of uterine contractions, whereas earlier the death of the fetus appears responsible. Students of the recent epidemics were unanimous in observation of an unusual tendency to abortion or premature delivery. Harris' figures[3] again are the most convincing. In his large series pregnancy was interrupted in 26 per cent of the uncomplicated cases and in 52 per cent of those accompanied by pneumonia. Among the fatal group abortion or premature labor occurred in 62 per cent. Apparently this added burden of abortion or premature

anoxemia and circulatory stress. Even in the absence of pregnancy the economy is hard put to meet this serious infection. The disturbed metabolism, the respiratory embarrassment from increased intra-abdominal pressure and the added circulatory load of pregnancy all contribute to the normal strain. If to this be added an infection of the nature of pneumonia, the gravity of the situation at once becomes apparent.

Abortion occurs in a majority of instances, especially if the pneumonia supervene in the late months of pregnancy. Transplacental infection, as well as anoxemia and toxemia, may contribute to this accident.[1] As Williams[2] pointed out, premature delivery is a greatly feared consequence of pneumonia in that the exertion of labor frequently precipitates a fatal outcome. Vinay's statistics[3] on the results of interrupted pregnancy in the presence of pneumonia are interesting. A maternal mortality of 68 per cent in the interrupted group compared very unfavorably with 15 per cent uninterrupted. Johnston and Morgan[4] reported the rather unusual picture of septicemia and pneumococcic endometritis of type I organism succeeding type I lobar pneumonia. The response to type I serum was entirely satisfactory; but the development of a streptococcemia led to death. These authors reviewed the literature on this interesting but rare clinical course.

As in any other infectious disease, the first consideration in the control of lobar pneumonia is prophylaxis. General hygienic measures to improve bodily tone and resistance must not be neglected in pregnancy. Undue exposure, fatigue and alcoholic indulgence should be eschewed. Respiratory infections of an apparently simple order precede practically every case of lobar pneumonia and due attention to their care will prevent a certain percentage of cases. Contact with patients suffering or convalescing from pneumonia should be especially interdicted to pregnant women.

The active care of lobar pneumonia complicating pregnancy is essentially the care of the infectious process. The newer antipneumococcic sera, after the formula of Felton, are useful early in the course of type I and possibly type II lobar pneumonia. Every measure of utility in its treatment under ordinary conditions may be applied here with the exception of such drugs as pituitrin, which are commonly used to control tympanites, an extremely serious manifestation under these conditions. In general, aside from the antiserum for type I pneumonia, the treatment must be symptomatic; but the early and continued use of oxygen to combat anoxemia cannot be too strongly urged.

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Pulmonary Tuberculosis.—In 1913 Bacon[1] estimated that 44,000 to 48,000 women of the childbearing period of life die each year from tuberculosis in the United States. This figure is appalling; but it closely parallels the curve of incidence of tuberculosis which reaches its maximum at the age period of from eighteen to thirty-five years. In the present relation the further statement that a total of 32,000 tuberculous women become pregnant

has its onset in the course of pregnancy or the puerperium. In his series of 240 cases of tuberculosis in women of the childbearing period, 151 (63 per cent) gave the history of the disease appearing first in pregnancy or in the puerperium. One hundred and three of this group of tuberculous individuals experienced their first symptom in the puerperium. Of this series of 151 patients, 36 were dead at the time of the report. Activation of a latent process seemed almost inevitable. Accordingly Trembley advised therapeutic abortion in all tuberculous women, unless the following conditions obtained: Inactivity of the lesion for a year, terminal stages of the disease and serious dissemination. Abortion before the end of the third month of pregnancy in his experience excited no adverse reaction. Norris and Landis[10] emphasized the serious prognostic significance of tuberculous laryngitis occurring in the course of pregnancy. In the presence of this complication or in active and progressive lesions they advised therapeutic abortion before the fifth month of pregnancy. In a review of this question Funk[11] quoted from various sources figures of 25 to 70 per cent of tuberculous women showing symptoms of activation in pregnancy. His attitude toward intervention was very conservative and sound. In the first place the course of an active minimal lesion should be closely observed before evacuation of the uterus is advised in the early months of pregnancy. If progression of the lesion be observed, abortion is indicated. Late in pregnancy, even in the presence of activity, intervention is contraindicated. The German viewpoint may be summarized in the advice of Zweifel[12] to abort early when necessary. The lay quotation, "Die Schwangerschaft mehrt; das Wochenbett zehrt," well expresses the threat of the puerperium; and Funk[11] has clearly outlined the illusionary improvement of early pregnancy which not uncommonly gives way to a sharp decline later in pregnancy or during the puerperium. Peham[13] warned that interruption in the second half of pregnancy, and especially in the last lunar month, is as dangerous as delivery at term. In an excellent analysis of the situation Pankow[14] reviewed the statistics and pointed out the need for a better organization of the information on the subject, in view of the unfavorable outlook in 75 per cent of cases of manifest tuberculosis.

Valuable as have been the several isolated contributions to the general knowledge of this question, the most fruitful plan of attack directed toward its solution has been advanced by Robinson.[15] Two hundred answers to a questionnaire evolved by him were received from Great Britain, Ireland, South Africa, Switzerland, France, Canada, United States, Australia, and China. One hundred and forty-six of 167 replies supported the position that childbearing, especially if repeated frequently or at short intervals, has a definite effect in developing a latent lesion. Late pregnancy and the puerperium were the favored times for activation in the opinion of the majority. Only a minority (28 of 181) thought that pregnancy was ever beneficial to the tuberculous woman. The induction of abortion was favored in 122 of 202 answers. The indications were not clearly defined but included the early active lesion and the reactivation of a quiescent lesion early in pregnancy. Sterilization was not favored by a majority; but in the negative responses contraception was advised by a goodly proportion.

If the validity of all of the advanced evidence be admitted, it will be perceived that the problem within certain limits is still an individual one. In no other condition is the physician's judgment and responsibility more

proportions of the germ cell and the bacterium would preclude any multiplication of the latter without serious encroachment upon the embryo. The experiences of Schmorl and Birch-Hirschfeld[19] and of Bar and Rénon[20] in producing experimental tuberculosis, by the injection of blood from the umbilical vein of children of tuberculous mothers into guinea-pigs, were significant in the apparent escape of the placenta. The freedom of the placenta from pathologic changes together with the isolation of acid-fast organisms from guinea-pigs after the injection of fetal liver or spleen pulp, in cases where the mother was known to be tuberculous, gave Calmette and his co-workers[21] further support for the theory of an ultramicroscopical stage of the tubercle bacillus, "ultravirus tuberculeux." Whitman and Greene[22] collected 28 authentic cases of tuberculous placenta with congenital tuberculosis of the fetus and listed 509 cases as doubtful. Tubercle bacilli were reported without histologic changes 21 times in the placenta and fetus and 3 times in the fetus alone. Other variations, such as the presence of the organisms in the fetus with placental tuberculosis and of organisms in the placenta, with and without histologic changes, were collected from the literature to a total of 44 instances. The details of placental tuberculosis have been thoroughly discussed by Lanz.[23] Congenital tuberculosis plays little part in the general problem. Most of such children are stillborn or die in early infancy. While the newborn of a tuberculous mother may be robust, Bacon's figures[1] of 75 per cent of 10,000 children below five years of age who die of tuberculosis being the offspring of tuberculous parents arrest the attention. Forssner and his fellow workers[7] state that of 34 babies taken immediately after birth from their tuberculous mothers, only 2 (6 per cent) developed the disease and 1 of the 2 died. On the other hand, of 89 babies allowed to remain with their tuberculous mothers, 40 (45 per cent) developed tuberculosis and of this group 22 died. A stronger plea for the separation of the mother and the child could scarcely be sought. The marked decline in the tuberculous mother with labor and in the puerperium should invariably prohibit the further drain of lactation. Finally the tuberculous patient should at all times through pregnancy receive every hygienic and dietetic attention accorded the nonpregnant tuberculous patient; and if repeated pregnancies threaten the ultimate recovery, sterilization should be recommended. Radiation offers the safest method of inducing this end and is available where surgery may be denied.

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